metal finishing Journal

PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, METAL SPRAYING and all METAL FINISHING PROCESSES

Founded 1930 as the INDUSTRIAL FINISHING JOURNAL

Vol. 5 No. 54 (New Series)

JUNE, 1959

THE SYMBOL OF SERVICE AND QUALITY

ESCOL

ESCOL FRITS

AND

ENAMELLING EQUIPMENT

ensure

CONSISTENT HIGH QUALITY PRODUCTION

ESCOL PRODUCTS LTD.

PAISLEY WORKS · SWAINS ROAD · TOOTING JUNCTION · S·W·17·

Telephone: MITCHAM 1634 (5 LINES)

Telegrams: ESCOL · TOOT · LONDON ·

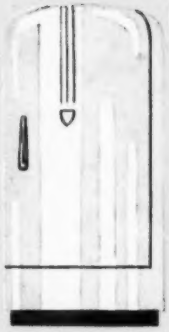
Frits!

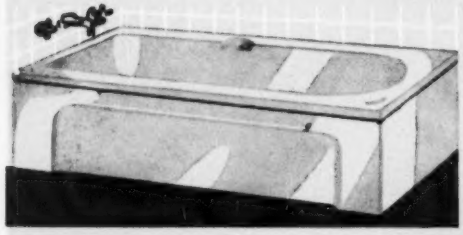
AND ENAMELS TOO

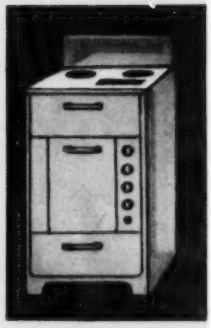
Blythe Colour Works are renowned, not only for their unequalled range of Frits for cast and sheet iron, but for their all-important after-sales service ensuring your absolute satisfaction.

Transparent or opaque enamels too, for application by wet or dry process, and concentrated oxides to give that vital spark of colour.

Blythe's exceptional facilities and recognised ability, coupled with specialised manufacturing technique, are always available to solve your particular colour problems; and remember—a Blythe technician is always at your service.







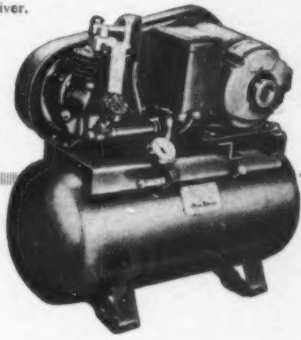
BLYTHE COLOUR WORKS LTD.
CRESSWELL · STOKE-ON-TRENT · ENGLAND
Telephone BLYTHE BRIDGE 2101

Blythe

home of the world's best colours

KE6 RAS, Single stage two cylinder compressor unit, working pressure 100 psi maximum with 7.5 hp motor. 13.4/cu.ft. horizontal air receiver. This type includes pressure switch and unloading device.

PE 2 RAS, Single stage, one cylinder, fully automatic compressor unit with 0.5 hp motor with 1.42/cu.ft. horizontal air receiver.



Complete small compressor range by Atlas Copco

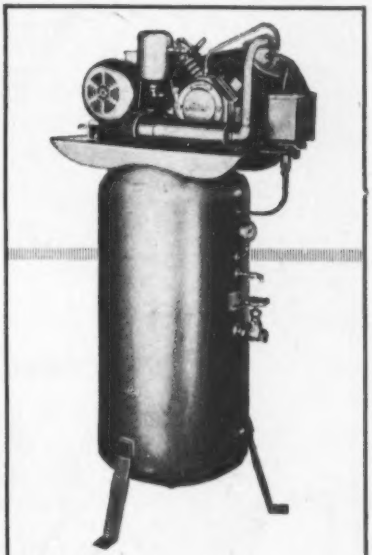
Small workshops or garages where the need for compressed air is limited can find a small compressor which will suit their needs exactly in Atlas Copco's complete range. Here are a few thing they will power: *Paint spraying—car hoisting—air for tyres—forced feed lubrication—sand blasting—metal and wood drilling—grinding—screwing and tapping—metal shearing—hoists—plug hole drilling—rivetting—engraving—stone grinding and polishing—operating door openers, etc.*

A COMPLETE RANGE BY WORLD'S LEADING MANUFACTURERS

How big is your shop? Atlas Copco's compressor equipment is as complete for smaller air users as for larger operations. From fractional horsepower units upwards, there is a versatile range of compressors and compressor units. Petrol and electric driven portables are available. All are fitted with either mechanical or electrical devices for maintaining working pressure without waste of power. All embody the many years of experience that have made Atlas Copco one of the world's leading manufacturers of air compressors.

WORLD-WIDE SALES AND SERVICE

Atlas Copco manufacture portable and stationary compressors, rock-drilling equipment, loaders, pneumatic tools and paint-spraying equipment. These are sold and serviced by companies or agents in ninety countries throughout the world.



KT 2 RGS, Two stage, fully automatic two cylinder compressor unit, working pressure 200 psi with 2 hp motor with 6/cu.ft. vertical air receiver.

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Write to Atlas Copco AB, Stockholm 1, Sweden, or contact your local company or agent.
In Britain write to Atlas Copco (Great Britain) Limited, Beresford Avenue, Wembley, Middlesex.

one minute

One minute of your precious time—that's all it will take to fill in the coupon below.

It will introduce you to valuable time savings in production and finishing methods from the use of E.A.C. 'shaped-grain' flexible abrasives. These coated abrasives, made by the latest controlled automation techniques, incorporate every worthwhile advance in design and manufacture. In the wide range of E.A.C. belts, discs, sheets and special shapes there is sure to be, for any operation, one that cuts faster and wears longer than those you are now using.

The right abrasive can save you money, let *us* find it for you; send now for samples, specifications, prices of the best abrasive for any operation in your industry.

change now . . . to

BRITANNIA EAC LIMITED "JOHN BULL"

coated abrasives

Please send your catalogue and price list of Metalworking coated abrasive materials to:

Name.....

Company.....

Address.....

.....

.....

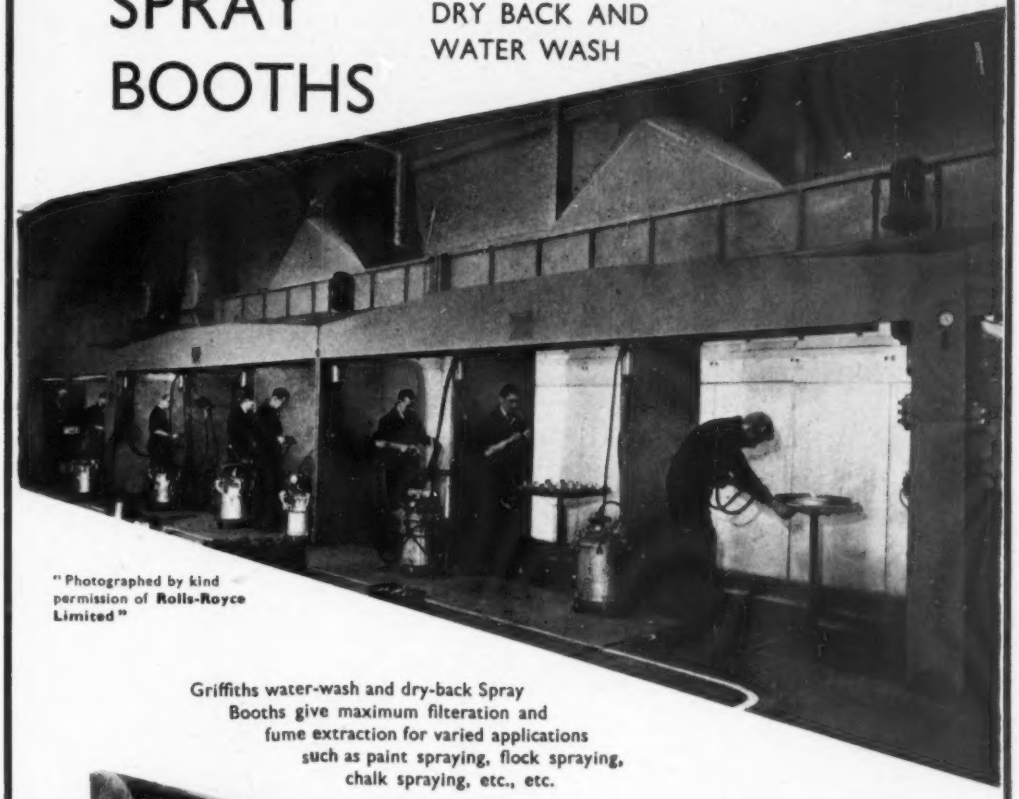
C6

ENGLISH ABRASIVES CORPORATION LTD
Marsh Lane, Tottenham, London N.17
Tel: Tottenham 5057

SUBSIDIARIES:
Thos. Goldsworthy & Sons Ltd
The Helvetia Abrasives Co Ltd
London Abrasives Ltd

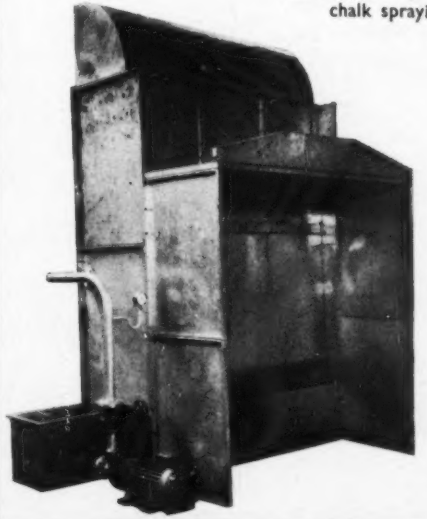
SPRAY BOOTHS

DRY BACK AND WATER WASH



"Photographed by kind permission of **Rolls-Royce Limited**"

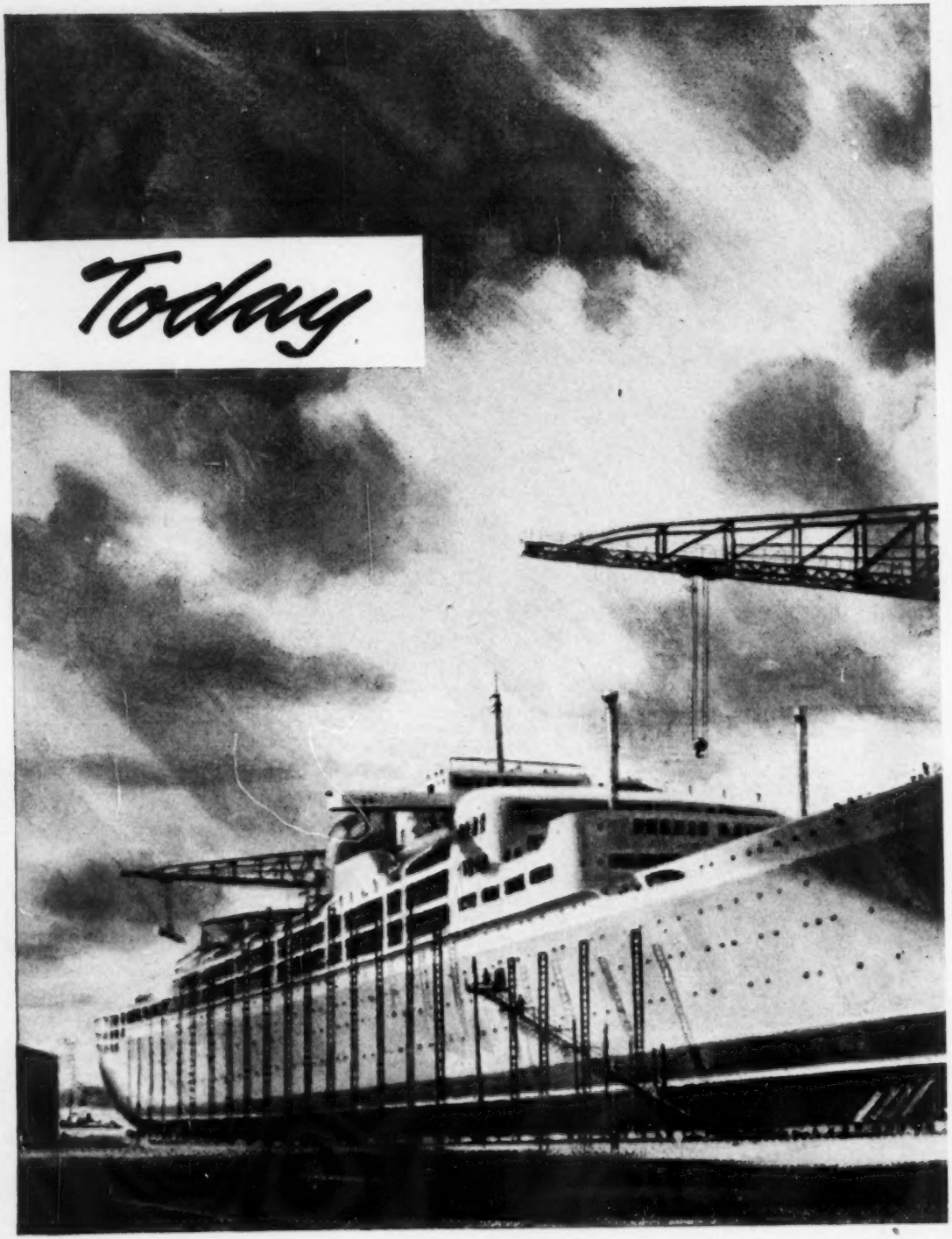
Griffiths water-wash and dry-back Spray Booths give maximum filteration and fume extraction for varied applications such as paint spraying, flock spraying, chalk spraying, etc., etc.

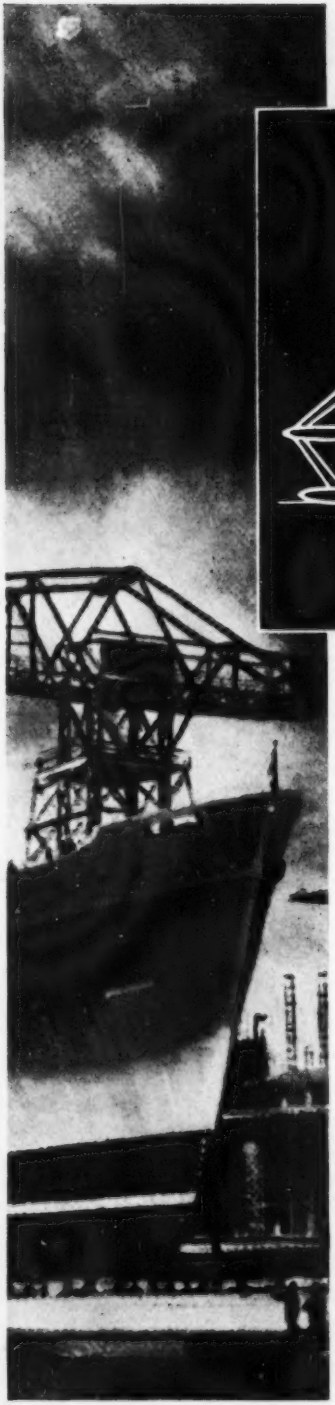


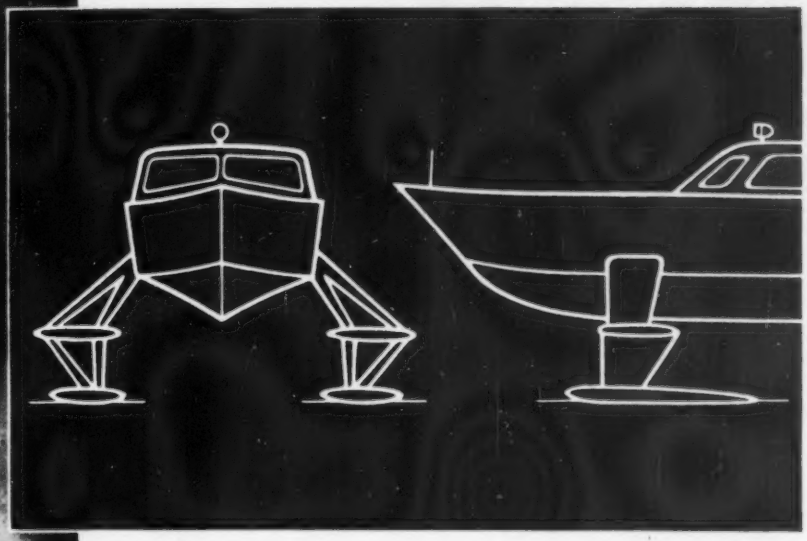
Dry-back Booths have internal lift-out baffles (no bolts or retaining clips to remove) and arranged to give graduated extraction across the frontal face of the Booth to provide maximum air flow near the work being sprayed, and minimum volume at the top of Booth for general ventilation.

A. E. GRIFFITHS (Smethwick) LTD.
BOOTH STREET, BIRMINGHAM, 21

Phone: SMEthwick 1571/5. Grams: Grifeven, Smethwick.


Today





Tomorrow

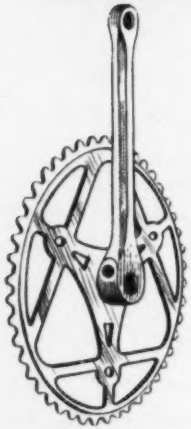
Today the Gas Industry offers excellent plant for the finishing industries,—while research on immersion tube heating and more economical radiant panels and stoving ovens will help to keep tomorrow's finishing costs low . . . **AND TODAY**— every industry and 12 million homes use **GAS.**

ISSUED BY THE GAS COUNCIL

A18/3Z

CANNING

AUTOMATIC ELECTRO-PLATING PLANTS DESIGNED TO MEET INDIVIDUAL REQUIREMENTS



E. Nicklin & Sons Ltd., Cycle Accessories Manufacturers, of Willenhall, ensure the consistent and superlative finish on their components by installing Canning Automatic Nickel and Chrome Plating Plant.

Manufacturers of everything for the Polishing and Plating Industry.

CANNING GREAT HAMPTON ST. BIRMINGHAM 18. LONDON & SHEFFIELD

Nuclear Fabrications

equipment for CLASS I weld dressing

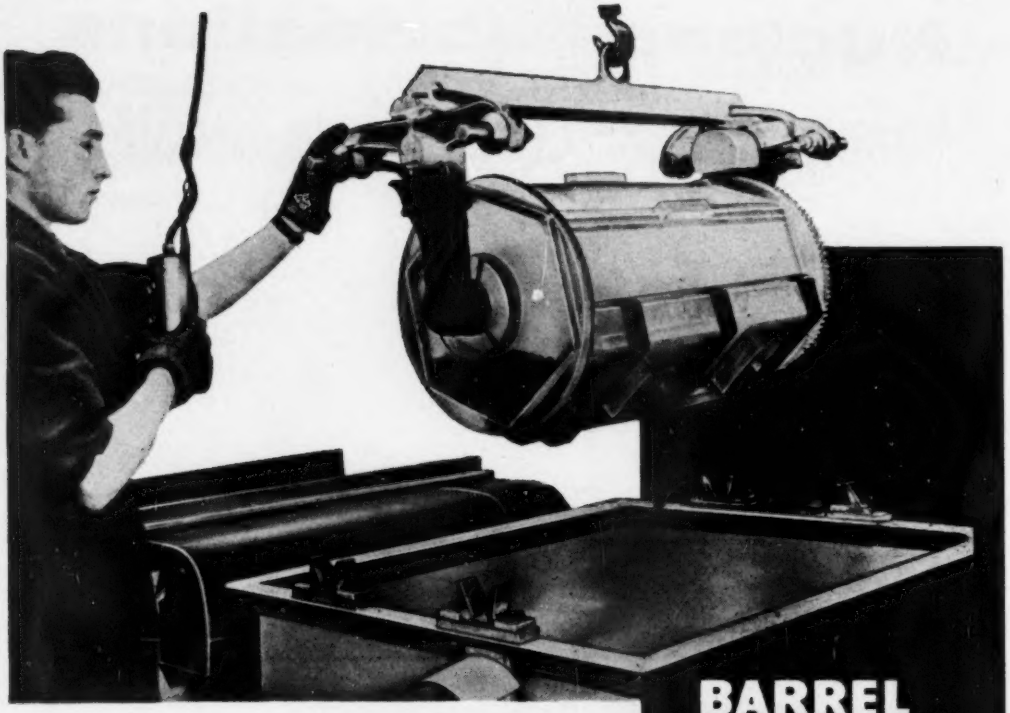
SPECIALLY DEVELOPED TUNGSTEN CARBIDE ROTARY CUTTERS FOR SPEEDS UP TO 100,000 R.P.M.
S.22 AND S.32 AIR GUNS OF HIGH POWER FOR OPTIMUM PERFORMANCE S.32 HAS SIDE EXHAUST WILL NOT COOL HOT WELDS
The S.22
Morrisflex
The S.23
The T.43
The H.16
COMPLETE RANGE OF PNEUMATIC HAMMERS FOR DE-SCALING WELDS
PNEUMATIC, HIGH POWER, CONTROLLED SPEED, KNOT WHEEL BRUSHING TOOL

B. O. MORRIS LTD., BRITON ROAD, COVENTRY

Telephone: **53333 (PBX)**

WILL BE GLAD TO ADVISE

THE MODERN TECHNIQUE



Efco-Udylite

BARREL PLATING EQUIPMENT

Designed for Maximum Output

Special well-proven features are built into EFCO-Udylite fully immersed plating barrels, such as high current carrying electrical contacts and large perforated area. Specification plating is thus achieved at the highest output per barrel, providing economies in labour, floor space and maintenance.

NBP 2493

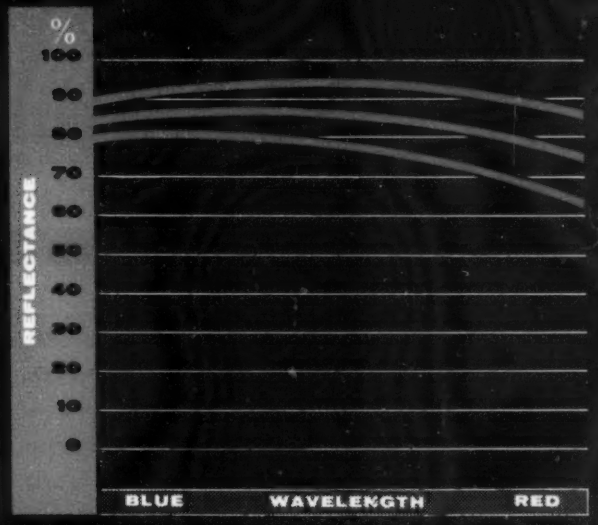
EFCO **ELECTRO-CHEMICAL ENGINEERING CO. LTD.**
SHEERWATER, WOKING, SURREY. *Telephone* WOKING 5222-7

constant ***colour tone and reflectance***

plus high density
free-flowing
easy mixing
high solubility
shorter smelting times

Tiona V

standardised Titanium Oxide for vitreous enamels in 3 types:



Tiona VC
Cream tone, (maximum reflectance)

Tiona VN
Neutral tone

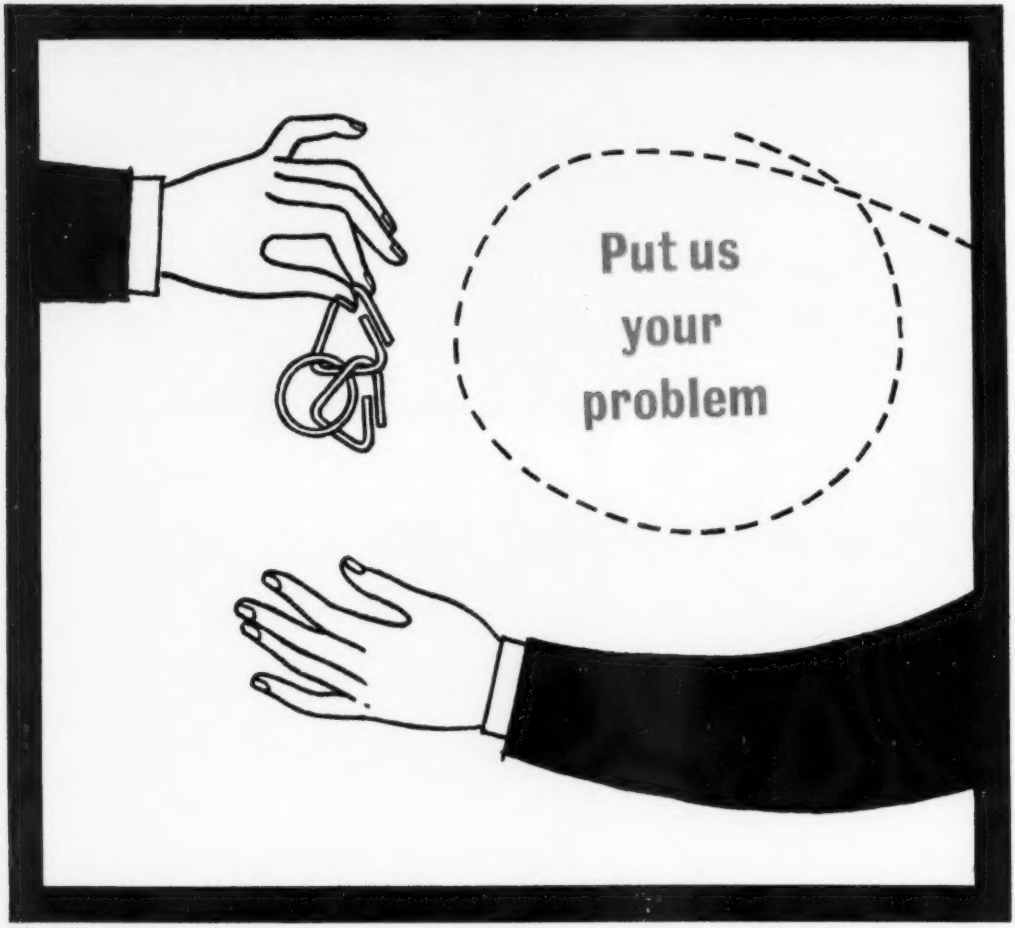
Tiona VB
Blue tone

LAPORTE TITANIUM LIMITED,
HANOVER HOUSE,
14 HANOVER SQUARE,
LONDON, W.1.
TEL: MAYFAIR 6001-5

30

Laporte Titanium Ltd.

L I L
A MEMBER OF THE LAPORTE GROUP



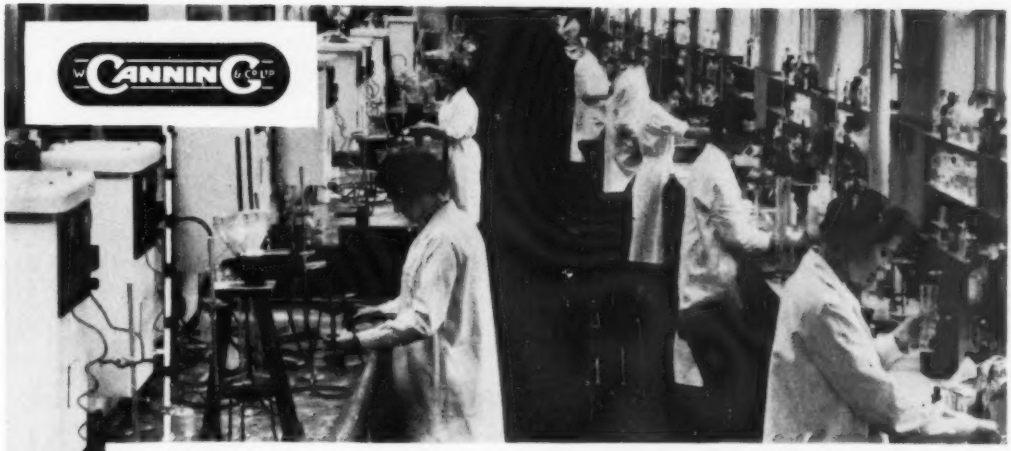
ME6

If it's anything to do with frits, colouring oxides or vitreous enamelling, we can help.

All our frits are shop-tested within our own organisation; all are proved in production and guarantee a fine finish. We are specialists in the production of dry enamels for bath finishes and can offer a fully acid-resisting and alkali-resisting lead-free enamel of exceptionally high workability. These are the sort of problems we have solved—put us on *your* problem. We like problems. Don't hesitate to call us in. MEMCOL is our trade name. Just write:

MAIN ENAMEL MANUFACTURING CO. LTD.

GOTHIC WORKS, ANGEL ROAD, LONDON N18

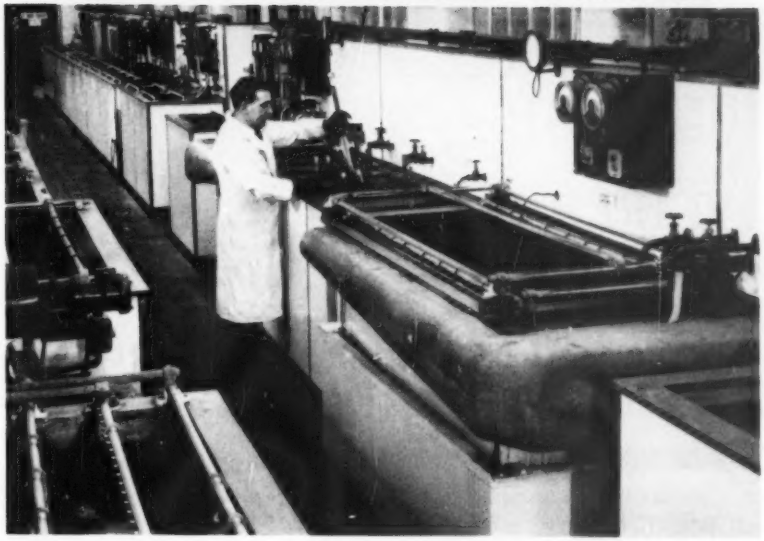


At Your **SERVICE**

Above—view of part of the Analytical Laboratories.

•

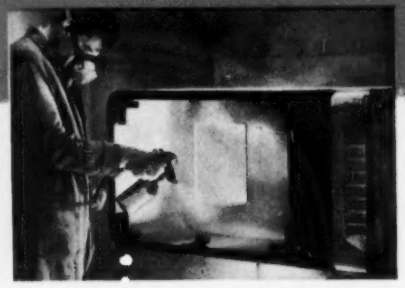
On right—part of the Plating Demonstration Shop.



The Canning Technical Centre in Birmingham with its up-to-date laboratories and fully equipped plating shop provides increased facilities for research and enables us to offer an unrivalled technical service to our customers. Whatever your finishing problem, whether cleaning, polishing, plating, bronzing or lacquering — our experts are ready to help and advise.

W. CANNING & CO. LTD. GREAT HAMPTON ST. BIRMINGHAM 18. LONDON & SHEFFIELD

What AIRLESS SPRAY means to you-



Saves paint up to 35% — higher build — higher gloss, more uniform finish — better adhesion of paint film to metal surfaces — reduces spray operator's time by 33⅓%. Healthier working conditions for operators. Cuts maintenance and clean-up costs of spray booths and much elaborate equipment is eliminated when fitting up new booths.

Send for our Special Airless Spray brochure.

The Airless Spray picture — shows clear cut spraying, the operator being free from the inconvenience of extra protective clothing and equipment because there is no rebound of paint particles. Spraying with Air picture (left) — shows heavy fog created by rebound of paint particles and overspray and the operator consequently must be completely protected.

Manufactured by

BD Airless SPRAY

T. C. SPRAY FINISHING SYSTEMS (BEDE) LTD.

5, St. James's Place, London, S.W.1. Telephones: HYDe Park 7186, 9370

"THREE ELEPHANTS" in every kitchen . . .

. . . Three Elephant Brand Borates, of course! These pure, versatile products give stronger finer vitreous enamel finishes and pottery glazes.

PYROBOR (Anhydrous Borax $Na_2B_4O_7$) gives very real savings in the preparation of vitreous enamel and glaze frits, because there is no waste of heat or time in driving off water of crystallization before fusion.

PYROBOR
V-BOR
BORAX
BORIC ACID

Lithium Ores
Lithium Carbonate
Lithium Hydroxide

BORAX AND CHEMICALS LIMITED
25 Piccadilly, London, W.1.
Telephone: REGent 2751 Cables: Boraxchem, London
Subsidiary of American Potash & Chemical Corporation

Producers of: Borax, Soda Ash, Salt Cake, Lithium, Bromine, Chlorates, Perchlorates, Manganese Dioxide and a diversified line of Agricultural and Refrigerant chemicals.

BAC/12A

Mr. Morris Isaac with an Atlas Copco Ecco 30 type spray gun beside a newly painted Massey-Harris-Ferguson tractor.

The Ecco 30 spray gun. The thumb tab next to the trigger spreads or narrows the fan of the paint spray at a touch.

Massey-Harris-Ferguson painter says:

'Finest spray gun I've ever used'

CANADIAN FARM MACHINERY at the Massey-Harris Ferguson plant in Woodstock Ontario is painted *entirely* by spray gun nowadays — the Atlas Copco Ecco 30. Since the Ecco 30 was introduced they no longer need to touch up hard-to-get-at places by hand. Today, a painter with an Ecco 30 can do the whole job far faster simply by narrowing or widening the fan of the paint spray as he works. Recently, on a government contract, Massey-Harris-Ferguson has used the Ecco 30 eight hours a day—and they found that the lightweight gun was faster than dip-painting. They also use the Ecco 30 on spare parts. The Ecco is light—the lightest in its class. It's built to last with tougher materials for the harder-worked parts. There are combinations of air cap and nozzle for any spray fluid. You'll find the Atlas Copco Ecco 30 the finest spray gun *you've* ever used.

A COMPLETE RANGE OF COMPRESSED AIR EQUIPMENT

Atlas Copco manufacture portable and stationary compressors, rock-drilling equipment, loaders, pneumatic tools and paint-spraying equipment. These are sold and serviced by companies or agents in ninety countries throughout the world.

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Contact your local company or agent or write to
Atlas Copco AB, Stockholm 1, Sweden, or Atlas Copco (Great Britain) Limited, Beresford Avenue, Wembley, Middlesex.

613

BALLARD

THE NAME CONVEYING OVENS

" The flexibility of a " Ballard " is acknowledged ! "

It is capable of handling articles of diverse weight, shape and size and with its wide range of stoving times and controlled temperature can satisfactorily deal with multifarious colours simultaneously.

" A " Ballard" at the works of Messrs. W. Redman and Co., producing road signal lamps."

F. J. BALLARD & CO. LTD. TIPTON, STAFFS.

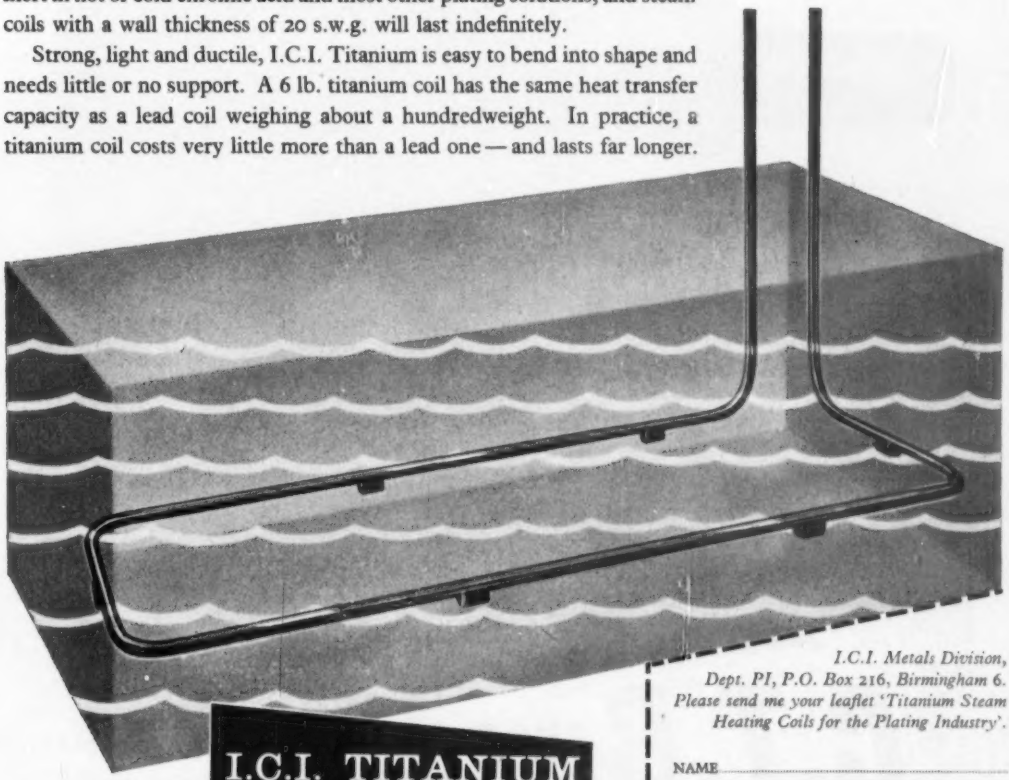
Titanium

heating coils for plating vats

Steam heating coils made from I.C.I. Titanium tubing — this is the new answer to the old problem of heating and temperature control in plating vats.

Used instead of a water jacket, titanium heating coils can cut steam consumption by 75% and heating time by 25%. Titanium is completely inert in hot or cold chromic acid and most other plating solutions, and steam coils with a wall thickness of 20 s.w.g. will last indefinitely.

Strong, light and ductile, I.C.I. Titanium is easy to bend into shape and needs little or no support. A 6 lb. titanium coil has the same heat transfer capacity as a lead coil weighing about a hundredweight. In practice, a titanium coil costs very little more than a lead one — and lasts far longer.



I.C.I. TITANIUM

ICI METALS DIVISION

TM 38a

IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON S.W.1.

I.C.I. Metals Division, Dept. PI, P.O. Box 216, Birmingham 6. Please send me your leaflet 'Titanium Steam Heating Coils for the Plating Industry'.

NAME .....

ADDRESS .....

.....

.....

Photograph by courtesy of Rolls-Royce Limited

More wear resisting than Tungsten Carbide

C.T.B SHOT BLAST NOZZLES

Glostics Ltd

AGENTS:
IMPREGNATED DIAMOND PRODUCTS LTD . TUFFLEY CRESCENT · GLOUCESTER

LUXOL

Polyurethanes

The nearest approach to vitreous enamelling

LUXOL Polyurethane coatings embody the latest discoveries in paint technology which enable—for the first time—cold hardening surface coatings to be obtained, having the nearest approach to the hardness and appearance of vitreous enamelling.

These finishes have, amongst other properties; excellent water and mild chemical resistance; good exterior durability, low flame spread and heat resistance up to 400°F., excellent resistance to crude oil, fuel oil, petrol, benzol, etc., and curing at a low ambient temperature.

The LUXOL Polyurethane Coatings comprise:-

1 **Primer for ferrous and non-ferrous metal. Ref: GR.142.**

2 **A Primer Filler for porous surfaces including wood. Ref: GR.167.**

3 **Pigmented and Clear Finishes.**

These coatings are all two-pack materials.

For complete specification, samples and literature post this coupon today.

Please send complete details of the LUXOL Polyurethane Coatings, to:

NAME .....

ADRESS .....

.....

M.F.J.

.....

BRITISH PAINTS LIMITED

Industrial Finishes Division,

PORTLAND ROAD, NEWCASTLE UPON TYNE, 2.
CREWE HOUSE, CURZON STREET, LONDON, W.1.
31, WAPPING, LIVERPOOL.

BELFAST, BIRMINGHAM, BRISTOL, CARDIFF, GLASGOW, LEEDS, MANCHESTER, NORWICH, PLYMOUTH, SHEFFIELD, SOUTHAMPTON, SWANSEA *and all principal towns.*

Presenting

for the first time in this country

"The Lacromatic"

DOUBLE CONE

FINISHING BARREL MACHINES

Introduced to meet the requirements of modern precision finishing, these new barrels will find widespread application.

★

Effortless loading and unloading with hand or automatic tilting mechanism.

★

Characteristic shape of work container gives new TRIPLE ACTION

★

Automatic timing device allows operation at night without supervision

★

Available in a range of sizes and with twin or variable speed motors

★

Manufactured under licence by :—

The HOCKLEY CHEMICAL Co. Ltd.

Sole UK Distributors for
"Lacromatic" Metal Finishing Media produced by
LACRINOID PRODUCTS LTD

Dept. EP. HOCKLEY HILL, BIRMINGHAM 18. Telephone NORthern 6201/6 Grams "HOKLYKEM" Birmingham

JW.Ad4642

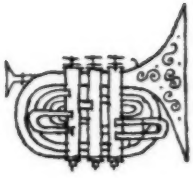
LAPORTE

INTRODUCE THEIR

NEW

RANGE OF

METAL CLEANING PRODUCTS



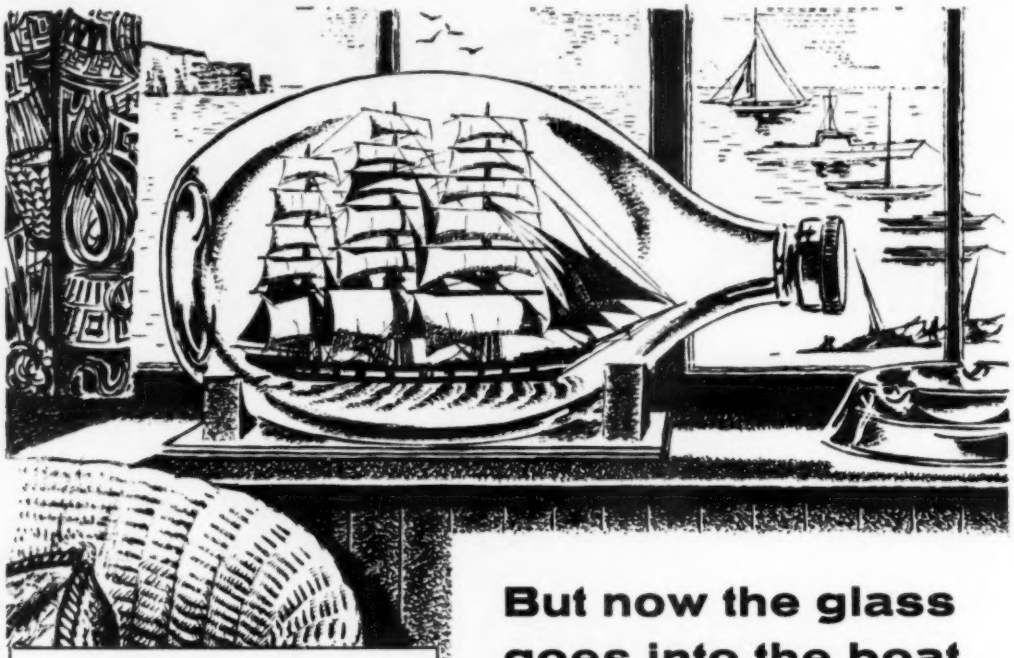
Metklens

L I L
A MEMBER OF THE LAPORTE GROUP OF COMPANIES

write to:
LAPORTE
for this free
Metklens booklet
LAPORTE CHEMICALS LTD.
LUTON
TEL: LUTON 4390

39

MORE IDEAS BEGIN WITH BORON



BORON IN VITREOUS ENAMELLING

Uses for borates are long established in the vitreous enamelling industry. The use of boric oxide makes possible the production of enamels of deep and brilliant colour which combine the properties of chemical resistance, low thermal expansion and low firing temperatures. It is also used to neutralise the steel sheets after de-pickling and to set the enamel slip.

(Photo: Courtesy Main Enamel Manufacturing Co. Ltd)

But now the glass goes into the boat

The well-known toughness of glasses such as ovenware, laboratory glasses and other specialised types, is largely due to the presence of boric oxide. This product is also an important constituent of the tough, borosilicate fibres which are now creating a new and completely different future for glass. These strong glass fibres are moulded with plastics into sturdy, lightweight structures for modern boat-building, woven into textiles for electrical insulation or made into 'blankets' to insulate a house. This contribution to a rapidly-expanding industry is yet another use for boron and boron compounds. In nuclear research, in rocket fuels, in new synthetic materials, as well as in established fields of industry and pharmacy, their varied properties give rise to many new possibilities for progress.

For further information on boron and its compounds, write to:

BORAX CONSOLIDATED LIMITED

BORAX HOUSE · CARLISLE PLACE · LONDON SW1 · TELEPHONE: VICTORIA 9070

'20 MULE TEAM' *Registered Trademark*

TGA BX 154A

metal finishing Journal

June, 1959 Vol. 5, No. 54 (New Series)

AN INDUSTRIAL NEWSPAPERS PUBLICATION

Editor : JOHN HOOPER *Assistant Editor :* E. H. LLOYD, A.I.M., A.C.T.(Birm.) *News Editor :* L. J. BACON
Southern Area Manager : E. COLLIS *Northern Area Manager :* G. P. ELLIOTT *Scottish Area Manager :* T. H. SMITH
Western Area Manager : E. J. SWEETING *Eastern Area Manager :* ERIC PERRIN
Production Manager : R. J. LOVELL *Circulation Manager :* E. T. GRIFFITHS *Publisher :* H. J. DWYER

Official Organ of the

INSTITUTE OF VITREOUS ENAMELLERS

President :
W. T. WREN

Chairman :
J. H. GRAY

Secretary :
J. D. GARDOM
John Gardom & Co., Ripley, Derby
Telephone : Ripley 136

Published on the 15th day of each month by

INDUSTRIAL NEWSPAPERS LIMITED

Directors:—
Barrington Hooper, C.B.E., *Chairman and Joint Managing Director*
Barrington Hooper, *Joint Managing Director*
F. R. Lewis
John Hooper
D. Horn
E. G. Weston, *Secretary*

JOHN ADAM HOUSE
17-19 JOHN ADAM STREET
ADELPHI, LONDON, W.C.2
Telephone : TRAfalgar 6171 (P.B.X.)
Telegrams : Zacatecas, Rand, London

Subscription Terms :
Home and Overseas 24*s.* per annum prepayable
Single copies 2*s.* (2*s.* 4*d.* *post free*)

THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING & ALL METAL FINISHING PROCESSES. THE EDITOR IS PREPARED TO CONSIDER FOR PUBLICATION ANY ARTICLE COMING WITHIN THE PURVIEW OF "METAL FINISHING JOURNAL" AND ALL SUCH ARTICLES ACCEPTED WILL BE PAID FOR AT THE USUAL RATES.

Contents

How Much is Enough ? **221**

Talking Points **222**
" Platelayer "

Industrial Metal Finishing With Paints and Organic Coatings **223**
J. J. Stordy, B.Sc., and W. G. J. Appleton, A.M.I. Mech.E., M.Inst.F.

Chemical Treatment Against Corrosion of Galvanized Steel Produced in Continuous Lines .. **237**
G. Odone and G. Milanese

Zinc Coatings on Iron and Steel **241**
A.K. Parker, M.A.

Overseas Review **243**
" Scrutator "

A New Metal Finishing Laboratory **244**

Thirty Years of Metal Degreasing **246**

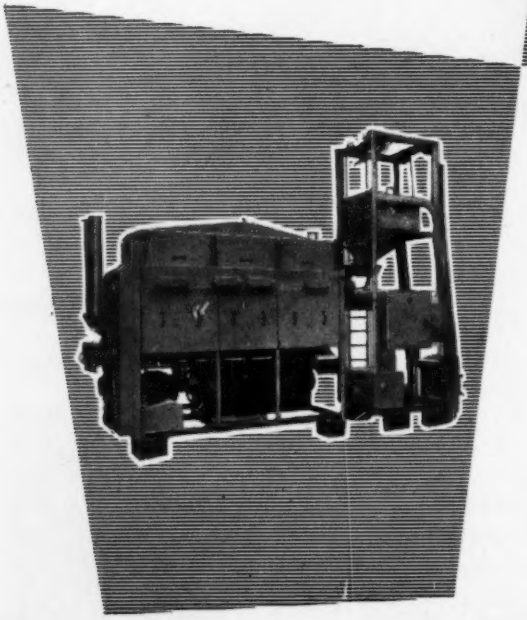
Finishing News Review **249**

Plant, Processes and Equipment **257**

As most of our readers will be aware, there is currently a dispute in the printing industry which has seriously affected the production of this issue of this Journal, which has in consequence been delayed in publication.

The circumstances are entirely outside our control as we are in no way a party to the dispute, and in expressing our sincere regret to all our readers and advertisers who may be inconvenienced by this state of affairs, we hope for an early and lasting settlement of the dispute, making possible a return to our normal pattern of publication. At the moment however, it appears probable that the publication of our next two or three issues will be subject to some delay.

Washing Bolts and Nuts Down Under



At an Australian Factory of Guest, Keen & Nettlefolds Ltd., bolts and nuts are washed, rinsed and dried by this Dawson Rotary Drum machine at the rate of up to 10/15 cwts per hour. This is only one of the many applications of this highly efficient metal parts cleaning machine which is widely used in this country and overseas for handling parts as widely different as H.E. Shells, hydraulic brake fittings, tap bodies and pipe fittings. And the Rotary Drum machine is only one of the Dawson range of metal parts cleaning units which are available for handling everything from small typewriter parts to large diesel engine cylinder blocks.

Dawson

DEGREASING AND CLEANING PLANT

Sole Distributors
DRUMMOND-ASQUITH (Sales) LTD.
King Edward House, New St., Birmingham
Tel. Midland 3431

Manufacturers:
DAWSON BROS. LTD., Gomersal, Near Leeds. Tel: Cleckheaton 3422 (5 lines)
LONDON WORKS, 406, Roding Lane South, Woodford Green, Essex. Tel. Wanstead 7777 (4 lines).

HOW MUCH IS ENOUGH?

THE decision taken by the American Society for Testing Materials Committee on Electrodeposited Metallic Coatings earlier this year to double the specified thickness of nickel in the specification for electrodeposited coatings of nickel and chromium on zinc and zinc-base alloys, is a pretty clear indication of the trend of thought in connexion with improving the durability and performance of plated zinc-alloy die castings. The new specification calls for a minimum thickness of copper plus nickel of 2 mil. of which not less than 1 mil. must be nickel and not less than 0.2 mil. must be copper.

The fact that no move was made to introduce the new specification until nickel was in abundant supply may be taken as a tacit implication that the earlier specification was dictated more by considerations of maintaining production than by a desire to ensure adequate performance of the coating. This is an attitude which has been for far too long apparent on the metal finishing scene, and the amount of harm which it has done to the electroplating industry must be considerable. Complaints concerning the performance of plated coatings, particularly on zinc-alloy die castings, have been legion in the post-war years and have lent considerable impetus to the quest for alternative finishes and materials. The argument has been put forward that it is better to have inadequately plated components than no component at all, and the stringency of the nickel shortage was such that all too often such a choice had to be made. One can still remember the effort that was put into discovering methods of replacing the missing nickel as an undercoat to chromium, both by established research bodies and by extempore organizations. That these were largely unsuccessful is a measure of the importance of the role played by nickel, which in its turn makes it all the more essential that these earlier inadequacies should be urgently adjusted now that the shortage is ended. Furthermore, direct action should be taken to dispel the unfavourable impression which has been created in the public mind by previous unfortunate experiences with regard to the performance of plated coatings.

From now on nickel-chromium plating must set itself out to bolster up its uneasy position in public favour, and to do this nickel must be applied in adequate thickness to reduce to the absolute practicable minimum the possibility of premature failure. Success in the campaign will depend largely on the effective use which is made of two weapons—specification and inspection. The industry must, in consulation with its customers and with the advice of its research workers, decide on what is the minimum required thickness to ensure adequate life for the coating, and this thickness must be specified whenever such coatings are applied. In achieving this there will, of course, be higher costs involved and the purchasers of plated coatings must be made to appreciate that the few shillings involved in ensuring adequate protection for their products are a very real economy.

Specifying a thickness however, is only a first step. Thereafter action must be taken to ensure as far as possible that specified thicknesses are in fact applied on all significant areas of each and every component. Therefore the provision of a simple effective inspection tool for this purpose is also a matter of high technical priority.

Electroplated coatings have a very great deal to offer in terms of corrosion prevention and eye appeal, provided that the thickness in which they are applied is enough to do the job for which they are intended. The answer to the question "how much is enough?" is "only enough is enough."

Talking Points

by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

WHEN IS A PLASTIC NOT A PLASTIC ?

WITH the growth of bureaucracy in all its forms we are reaching a stage where one group may have a vested interest in making a technical term mean one thing and an opposing group another. The outcome of the dispute may have far-reaching consequences, and the commonly understood definition can become completely distorted in the process.

Several examples of this have occurred lately. For instance, the decision, after a lengthy enquiry, that polythene is not a synthetic organic chemical to the Customs authorities has meant that British manufacturers of this material now have to face much more severe competition from abroad.

Again, one Trade Union is claiming that resin-bonded glass fibre is a plastic, and therefore, doors and fittings on ships made from it must be installed by craftsmen of the Woodworkers Union. Another Union claims that it is not a plastic, but it can be assumed that the accepted technological classification of the material as a plastic will not be the deciding factor in arriving at a decision. Recently, there was a long strike over whether aluminium-faced plywood is or is not wood, and with the advent of further new products, such as plastic-steel laminates etc., we can foresee battles developing with Trade Unions, Customs Authorities, purchase tax assessors and others.

Let us hope no-one has to decide whether electroplating is sheet metal, or electrical or chemical work.

PLUMBING—A LA FRANCAIS

WHEN it comes to translating technical terms from one language to another ordinary dictionaries are not merely useless—they can be entirely misleading. A dictionary should give as many possible meanings of each word in one language which it can have in another. On the other hand, in translating a technical term into another language only one precise word is usually applicable if the correct sense is to be conveyed, and this word often has a meaning quite remote from the normal non-technical one.

For this reason, a new booklet published in France by the Syndicat National du Revetêment et Traitement des Metaux is a useful contribution to international understanding in metal finishing. It is a glossary of some one hundred technical terms used in metal coating and treatment with their equivalent meanings in English, German, Italian and Spanish. Reasonably complete and well arranged, the definitions and translations are both clear and, on the whole, accurate. There is only one solecism in the booklet and the fact that this is a real " howler " emphasises the difficulties and pitfalls involved in preparing a publication of this kind. The term " plombage," which of course means lead coating, is translated into English as — " plumbing " !

" VITREOUS INDIFFERENCE "

THE considerable improvements in anodized and coloured aluminium for external service which have been made in recent years has resulted in very extensive use of such panelling across the Atlantic. In this country, however, aluminium structural panelling is still being used only on a very limited scale. This can hardly be due to lack of information on the subject for the aluminium manufacturers have given a great deal of publicity to the technique.

Most new buildings, especially in the City of London, are of the heavy classical stone type, barely distinguishable from those erected 50 years ago. Apart from the stodginess of this type of construction, concrete in London becomes dirty and even crazed and very soon looks shabby.

The public will soon have an opportunity of seeing aluminium panelled construction on a large scale in London when the new United States Embassy is finished, but so long as our leading architects subscribe, consciously or otherwise, to the view of Professor Sir Albert Richardson (designer of Bracken House and a Past President of the Royal Academy) that the modern style is " a monstrous repetition of cellular facades cloaked with vitreous indifference " we shall continue to have stone and brick buildings on a large scale.

TECHNICAL TOTS

IT is hardly possible to open a journal these days without reading something of the wonders of Russian technical education and the vast number of scientists being turned out each year in that country. According to a recent book about children in the Soviet Union by the Russian author Kornei Tchoukovsky the use of technical terms seems to start at quite an early age. He records the case of a four-year-old child of a journalist who said to his mother : " Mother, to-day I'm as tired as a 120-volt bulb working on a 220-volt current without a transformer."

Let us fervently hope that we do not get too many precocious wretches of this kind here as a result of too much technology !

Industrial Metal Finishing with Paints and Organic Coatings

*A Survey of Modern Practice and Techniques**

by J. J. STORDY,† B.Sc. and W. G. J. APPLETON,† A.M.I. Mech E., M.Inst.F.

IN 1955 the author's presented a paper to the Eastern Counties Section of the Institution and the endeavour of this present paper is to compact, in so far as is possible, the previous information and to amplify certain processes which have developed in the intervening period of time.

The terms of reference are similar to those previously utilised, viz :—

(a) The preparation of the base metal, or pre-treatment.
(b) Types of finishing materials commonly employed.
(c) Methods of application.
(d) Drying of the applied coatings.
(e) Description of types of plant available.

As in the original paper it has been assumed throughout that metallic bases are to be considered.

Pre-Treatment

It is now an established practice that, in order to obtain a good final result, much attention has to be paid to the preparation of the base metal which is to receive the protective or decorative coating ; and failure to recognize this fundamental necessity does result in considerable trouble in the paint shop. It will be appreciated that in the course of manufacture almost every article accumulates, to a greater or lesser degree, scale, dirt, oil, finger marks, etc. all of which can affect the final finish and that, prior to painting, the removal of the contamination must be carried out.

As a broad classification, the degree of cleanliness can fall under one of three main headings :—

(i) Generally clean
(ii) Grease free
(iii) Chemically clean

By "generally clean" it is understood that a portion of the dirt has been removed but that traces of contamination are in all probability still remaining and, to give this degree of cleanliness, mechanical means are used, also certain chemical methods such as pickling.

By "grease free" it is understood that a completely oil and grease-free surface is produced by solvent degreasing treatment but which, in all probability, leaves a surface retaining traces of scale and surface oxides.

"Chemically clean" infers a base metal from which all surface contamination, such as oil, dirt, scale, etc. has been removed and, as will be realized, is the most difficult to prepare, and such surfaces are usually attained by treatment in chemical solutions.

The necessity or otherwise for pre-treatment, and the sequence of processes prior to the application of the surface coating must receive very serious consideration, to ensure not only the durability of the final coating but also that the process shall be the most economical.

It can be broadly stated that when a surface in the finished state is to be left bright and clean, then a "generally clean" surface will suffice. For coatings which require good adhesion to the base metals, such as paints and varnishes, then not only is a surface "generally clean" but also "grease-free" required. For surface coatings requiring a physic-chemical bond, *i.e.* electroplated metal, then a "chemically clean" surface is essential.

Generally clean surfaces can be produced by grinding, wire brushing, sand or shot blasting, steam or flame jet, or by tumbling, polishing or buffing. In addition, hand-wiping with solvent or thinners may be used. Such methods of cleaning are so well-known that it is not proposed, in this paper, to deal with them and in any case polishing and buffing are outside the terms of reference which we have postulated.

As previously stated, in the course of manufacture of metallic parts, contamination of the surface with scale and grease will take place, and this contamination must be removed if it is desired to apply a protective coating to the processed article. For removing heavy deposits of oil and grease on work, a common method is to immerse the parts in organic solvents, such as petroleum,

*Based on a paper presented to the Wolverhampton Branch of the Institution of Production Engineers, November, 1958.
†Stordy Engineering Ltd.

benzene, white spirit, etc. which while efficient, suffer from the serious disadvantage of being highly inflammable, and of course constitute a fire risk. Furthermore, on parts of intricate shape there is always the danger of the degreasing medium being carried out with the work and this may cause trouble on the following process. For this reason non-inflammable, chlorinated hydrocarbons, such as trichlorethylene or perchlorethylene are now commonly employed in the finishing shop, and are used warm providing adequate precautions are taken.

It cannot be stressed too strongly that in any process involving organic solvents of these types, regard must be paid to the toxicity of such compounds which, when heated above the recommended limit, form corrosive hydrochloric acid.

The majority of trouble which can arise with organic solvent degreasers in liquid form, due to carry over etc., can be almost completely overcome if vapour degreasing is used, and the process gives extreme flexibility and not only can it be used for metals but, with certain limitations, almost all sizes and shapes of components.

The form of plant used is so well known that it is not proposed to describe the equipment in any detail, but it should be mentioned that the efficiency of cleaning depends chiefly on the difference of temperature between the workpiece and the solvent vapour, the lower the workpiece temperature the greater the condensation and therefore the greater the amount of surface cleaning and grease removal, this continuing so long as the workpiece remains in the vapour zone but diminishing as the workpiece temperature approaches that of the vapour.

While organic solvent degreasers are extremely efficient in removing grease, dirt and similar contamination will not be removed unless a ready-flow of condensate over the workpiece is obtained. This difficulty may be overcome by using a jetting system as part of the vapour-degreasing equipment, or a combined liquor/vapour plant, the first section being liquid in which the workpiece is immersed, with a following vapour section to finish off the cleaning and to remove traces of solvent.

While organic-solvent degreasing units of the trichlorethylene type are very widely employed, due to their compactness, also their low running cost, it is sometimes preferable to use emulsion-type or alkaline-type cleaners.

Emulsion cleaners are normally based on petroleum or coal-tar solvents, with an emulsifier so that an emulsion is formed with water and can be used either as dip type plants or for spray cleaning. Sometimes in the spray type of plant paraffin in an aqueous alkaline solution is used, and such emulsion cleaners are perfectly suitable for generally clean and grease free conditions. If a chemically clean surface is required, however, then it is necessary to follow emulsion cleaning with alkali degreasing or vapour degreasing. Normally emulsion cleaners work at water temperature without the application of heat though, in some cases, accelerated conditions can be obtained by the use of heated tanks.

In the case of alkali cleaning mediums, these usually have a basis of caustic potash and soda ash with additives such as sodium phosphates, silicates etc., also synthetic wetting agents. The mechanism of operation of such solutions is by the saponification of vegetable oils and greases and the emulsification of these and mineral oils.

With either emulsion or alkali degreasing processes, it is an essential to have following rinses, the first rinse being of the cold type with free-running overflow in order to prevent build-up of alkalinity, the second tank generally being a warm tank.

While the majority of work which is formed of sheet steel, mill scale does not present a problem to final finishing ; where this type of scale is present, or heavy rusting has occured, then it is essential that this be removed, and many methods are employed to accomplish this end, all of which are well known.

Phosphating

The necessity for the preparation of metallic surfaces before the application of coating material is now widely appreciated, particularly with the high degree of finish which is obtained on modern strip mill production, and for this reason phosphate coatings are increasingly employed. While phosphate coatings have normally, almost exclusively, been used for their corrosion protection properties, they are now finding increasing application for assisting the cold working of metals and as aids to lubrication. In addition to the provision of a non-conducting bond between the base metal and the coating material, it is claimed that a phosphate coating has the property of retarding the ageing of the organic finish.

Brush and hand-spray methods of phosphating are in use, but the most generally utilized application is by dipping in static tanks or by passing the work to be processed through spray chambers on a conveyorized system. The fineness of the resulting crystalline coating will in some measure depend on the previous method of cleaning and the type of solution which is used, also the degree of protection which it is desired the phosphate coating shall give.

When used as a pre-treatment for painting with immersion-type equipment, immersion times of from one to five minutes are used depending

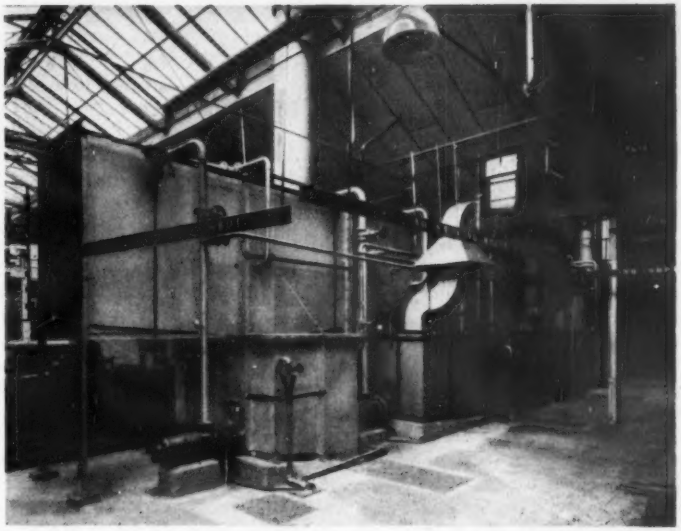


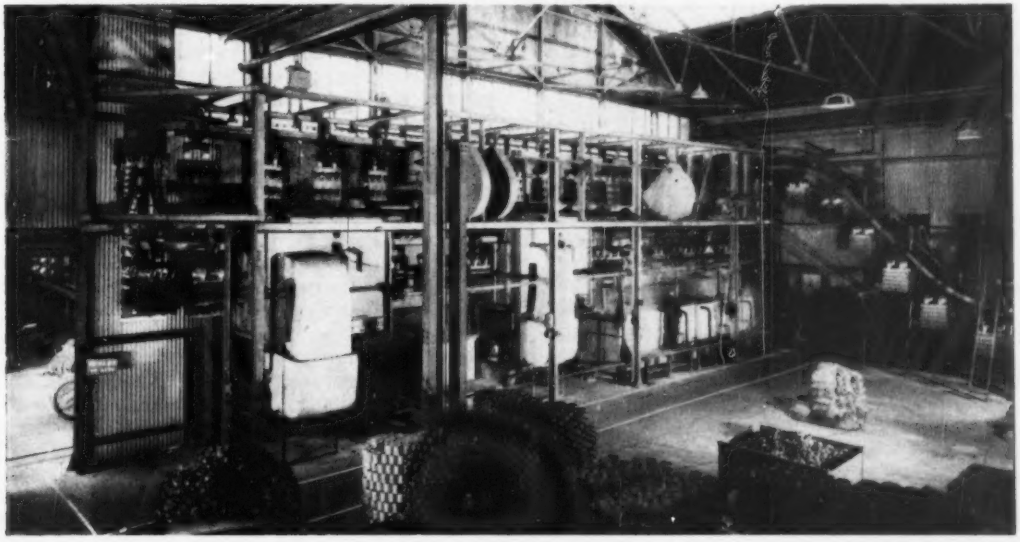
Fig. 1.—Five-stage spray phosphate plant used in the production of lawn mower components. Tanks and air circulated oven are all arranged for town gas firing.

on the type of solution and the temperature of operation and, in broad terms, the operating temperature of the tank, again depending on the type of solution, is generally between 130 and 170°F.

With the jet or spray method, phosphate treatment times can be reduced to one minute or less.

In Germany during the war years, and due chiefly to the shortage of fuel, cold phosphating solutions were used, and these solutions were very dependent upon the efficiency of cleaning operation prior to phosphating and, since they operated at high strength, the loss substantially reduced any economy which could be effected due to lower fuel cost. Very recently, however, in America, also in this country, so-called " cold " phosphating solutions have now been developed and it is possible to obtain a coating entirely adequate for surface preparation to receive a final organic coating by these cold phosphating methods which work at a maximum temperature of 110°F. Furthermore, and in connexion with this new process, and if the surface contamination

Fig. 2.—Dip type degreasing and phosphating plant used for the cleaning, phosphating and varnishing of tube fittings. Conveyor having intermittent motion with drop sections over process tanks.



is not too great, cleaning can be carried out in solutions running at roughly similar temperatures, so that the overall fuel cost is very considerably less than is necessary with even the lightwieght coatings which have been so popular in the finishing industry during the last few years. It should be stated that cold phosphating and lightweight coating treatments have no rust—removing properties and normally can only be used on bright surfaces. They do, however, possess some detergent qualities and, particularly with the lightweight types of material, can be used as a combined cleaning/coating solution. When lightweight coatings are used as immersion operations, great care must be taken of the cleaning and in some cases it may be necessary to include for both alkali or emulsion cleaning, followed by water rinsing before the phosphate treatment.

After phosphate treatment, of whatever type, it is usually necessary to provide two rinses, the first rinse being a cold one with a constant pre-set overflow to reduce contamination in the tank, the second stage being preferably a heated rinse with a slight addition of chromic acid, the usual percentage being approximately 0.2 per cent to passivate the phosphate film.

Paints

The most commonly used organic coatings can be roughly divided into four main types :—

(i) Finishes of the oxidizing pattern in which a hardening occurs after evaporation of the solvents. The majority of air-drying finishes are in this group.

(ii) Finishes of the evaporative type, such as cellulose, varnishes and lacquers, and more modern finishes based on such synthetic materials such as vinyls, in which the coating material is carried in a solvent which hardens after the solvent has been evaporated.
Some of the chlorinated-rubber or rubber-derivative materials can also be included under this heading.

(iii) Synthetic-base materials in which chemical reaction is brought about in the material by the application of heat, the process being known as polymerization.

(iv) Synthetic materials in which chemical reaction is brought about by the addition of acid or alkaline catalysts in the paint. Such products are nearly always two-pack materials.

Finishes of the first type, generally classified as oil paints consist of a combination of a solid constituent whose purpose is to obscure the base metal and to provide colour etc., with a liquid constituent to give adhesion. The solid constituent normally consists of blended pigments to give the desired shade, also chemical stability and resistance to discolouration. The liquid constituent comprising a natural oil with driers to regulate the drying operation and a volatile solvent to give the required viscosity. Acid refined linseed oil is the principal drying oil used in this type of finish, the moderate degree of acidity facilitating the wetting of the pigments by the medium. Many oxidizing paints, of course, employ mediums of more complicated formulation where the natural drying oil is replaced by heat-treated oils and varnishes.

Under finishes of the second type, the most commonly used are of course celluloses which can be classified into three main groups, *i.e.* nitrocellulose, cellulose acetate and ethyl cellulose. All cellulose materials have in themselves poor adhesion, are brittle when hard and have little or no durability and, in consequence, finishes of this type incorporate resins and plasticizers whose purpose is to give gloss and adhesion and to improve durability. Broadly speaking, resins are added in order to give gloss and adhesion, and plasticizers such as camphor and castor oil to give durability and, while the solvents evaporate very quickly, the ideal plasticizer is one which while having compatibility with the other ingredients is non-volatile and is chemically stable and inert. Lacquers and varnishes are transparent viscose liquids which solidify into a hard lustrous film to protect the surface without obscuring it. The so-called " half-hour " synthetics generally have a resin-fortified cellulose base designed to give a thicker coat than can be obtained with a straight cellulose and better flow. The drying period being consequently retarded to give these conditions.

Polymerizing, or the third type of finish, is now universally used for stoved coatings and is based on a combination of synthetic resins. The advantage of synthetic material, as opposed to the natural substances which were used industrially before the war, is that the structure of the resin can be pre-determined by the paint chemist and, in consequence, it is then possible to manufacture an identical material under controlled conditions.

Materials of the fourth type are, in the main, those which contain acid or alkaline catalyzed urea resins and normally are used in wood finishing. Also, of course, in recent times the advent of epoxy resins, with an acid catalust, have been widely used. The catalyst is necessary in order to enable a reduction in the drying temperature which most often is dictated by the end product. Also in this class are etch-primer type materials which are usually based on a poly-vinyl resin, pigmented with a zinc chromate, and to which is added a solution of phosphoric acid. Finishes of this type give extremely good adhesion to metals and are sometimes used in lieu of pre-treatment

processes, particularly on metal such as aluminium. Each type of resin has its own advantages but unfortunately its disadvantages too, the special advantages of the resins which have been mentioned above may be briefly summarized as follows :

Phenols — hardness allied with non-inflammibility.
Alkyds — elasticity
Ureas — resistance to discolouration
Melamine — heat resistance
Vinyls — surface adhesion
Epoxys — resistance to moisture attack and hardness.

Plant

In considering the preparation of the basis metal it is necessary to give first consideration to the type of plant which will be employed in the production. If a multitude of small parts is to be processed or production is comparatively small then almost certainly the best type of cleaning unit will be of the batch pattern, since the capital cost of such a unit is very considerably less than conveyorized equipment, though of course the batch-type plant has the disadvantage of handling between process tanks. Organic-solvent degreasing methods have been discussed at some length earlier in this paper, but the authors feel that it would be useful very briefly to cover this ground once more.

When heavy grease deposits are present and it is proposed to use trichlorethylene or perchlorethylene for grease removal, then a combined liquor/vapour plant, or vapour plant with jetting should be considered. Such plants are available of the conveyorized pattern and can be obtained in a large variety of forms as standard units. It must be borne in mind, however, that the degreasing medium is toxic and it is not good general practice to make a conveyorized organic solvent degreaser as part of a production conveyor line. Further, in order to avoid trouble which may arise in the paint section of the line it is desirable that the degreasing unit is as remote from the point of application of paint as possible, since the acid content of the degreasing medium can cause considerable trouble in the finished paint film.

Where, in place of a solvent degreasing medium, an alkali degreaser is utilized, then the degreasing tank can form part of the pre-treatment line. Such tanks are arranged normally with heating coils employing steam or high-pressure hot water as the heating medium, or where steam or hot water is not available, then gas or electric immersion heaters can be employed. Generally, a runway beam is provided on the centre-line of the tanks, the parts being loaded on a suitable jig, or in baskets and processed from tank to tank. Normal materials of construction are used for the degrease tanks, *i.e.* mild steel, and also for the following rinses. Where an acid pickle is utilized then the type of lining of the tank and also the method of heating will be dependent on the acid employed. For sulphuric and hydrochloric acids, either lead or rubber lining is desirable, the heating preferably being by means of a water or oil jacket around the tanks sides and bottom. Where phosphoric acid is the pickling medium, then a rubber-lined tank can be utilized, once more preferably heated by jackets as for the sulphuric and hydrochloric acid examples.

For rinses after the pickling stage it is necessary that these shall be suitably protected, the cold rinse tank which normally follows the pickle tank being arranged for the constant make-up in order to avoid acid build-up.

For the actual phosphating tank, the material of construction will be dependent on the type of solution employed, but mild steel is very widely used indeed with much success, though for some materials, stainless materials or rubber linings should be employed. Rubber lining does, of course, reduce the build-up of phosphates on the tank sides. For heating, immersion coils can be employed but it must be appreciated that the heating efficiency of coils will progressively fall as the phosphate coat builds up, and here a jacketed tank has much in its favour. Where immersion coils are used these can be of steel brass or corrosion-resisting material.

Rinsing following phosphating need no special precaution, mild-steel galvanized tanks being generally used.

Process times will depend, to a large extent, on the amount of contamination, the type of pickling acid and the thickness of phosphate coating required but, generally speaking, times from 2½ to 5 minutes to the tank are used. The working temperatures also of the various tanks will depend upon the requirements of chemicals used but as a general rule hot degreasing tanks run at temperatures of between 170 and 190°F., phosphating tanks between 135 and 180°F. and warm rinses generally between 170 and 180°F.

In order to prevent escape of steam into the surrounding shops space, modern practice tends to the provision of a lip extraction system which comprises a narrow slot along two sides of the tank length through which a high-velocity air stream is induced. The velocity through the slot for effective collection will depend upon the width of tank being used and can vary from a low level of 1,000 ft. per minute to a high level of 3,000 ft. per minute. Where corrosive fumes are likely to be encountered, then it is necessary to construct the exhaust ducting in an acid-resisting material such as P.V.C. or to rubber-line such ducting.

For the remainder of the process tanks, mild-steel

trunking galvanized after manufacture is perfectly suitable.

As has been mentioned earlier, modern mass-production methods tend rather to use spray cleaning and phosphating than the dip method, since treatment times are very considerably reduced, though dip methods are employed on continuous plants with very satisfactory operation. Generally, in a spray plant, a monorail conveyor system is employed, the work being suitably jigged and hung from conveyor trolleys, The great advantage with spray plants is that, after loading, no further handling of the work is necessary until the pre-treatment process has been completed. It is not, however, usual to incorporate a pickle stage in such lines, the normal procedure being to arrange for two degreasing tanks with two following rinses, for the phosphate stage, its following rinses and finally a dry-off oven.

Spray headers are suitably disposed around the conveyor and are provided with jets of various forms arranged to fire in all directions so that every part being processed receives jetting from the sprays, and for this purpose, a spray pressure of approximately 20 to 25 lb. per square inch is employed.

Pumps of normal construction can be utilized though it must be appreciated that where heated tanks are used it is essential that the pump has a characteristic suitable for handling heated liquors and should work normally under flooded suction conditions.

Incorporated in the tank is generally arranged a weir in order to prevent sludge being drawn into the pump and thus discharged through the pressure system and which may tend to block up the small orifices in the jets themselves.

The drying oven which follows the process section is normally of the air-circulated pattern, running at temperatures from 250 to 350°F. depending on the time which can be allowed. This time varies from a low level of 3 minutes upwards. The advantage of an air-circulated system for this process is that providing the method of distribution is well designed, the formation of water droplets on the treated work is avoided. It is a comparatively easy matter to dry a surface wet section but very difficult indeed to boil off a water droplet, thus comparatively high air velocities are used throughout the drying oven in order to spread out such water droplets and to accelerate the total drying of the work.

One further point in connexion with the conveyor system is that it is essential in so far as it is practicable that the chain and rotating parts are shielded from the cleaning sections in order to reduce phosphate build-up which can result in a very heavy maintenance item. If at all possible, it is desirable for the conveyor system to be external to the spray enclosures. Where lightweight coatings are employed then the tendency to form build-up on the conveyor does not occur to the same extent and, furthermore, sludging troubles which are present with heavy-weight coatings, are correspondingly reduced.

Before leaving this section it should be mentioned that there are now available continuous paper filtration systems in order to reduce the amount of sludging necessary to process tanks and which have been used with very great success, the solution being pumped from the settling tank to the filter unit which is very often mounted above the spray section, the clarified solution then returning by gravity to the process tank.

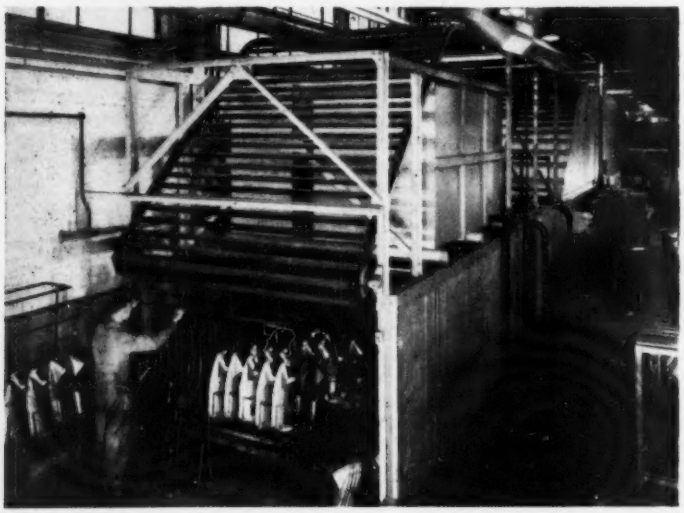


Fig. 3.—Loading end of flight bar type conveyor system showing parts loaded for automatic dipping, draining and stoving. Two dip tanks are utilised side by side, one containing Japan Black and the other red oxide primer. Overhead storage tanks are seen in the illustration.

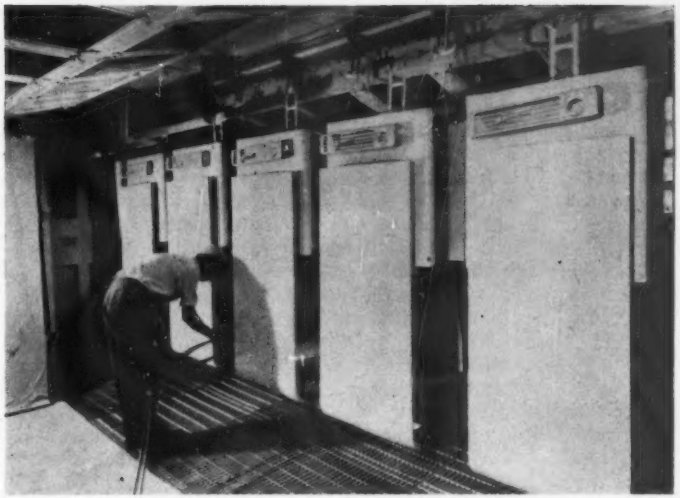


Fig. 4.—Down draught spray booth on a refrigerator finishing line.

Paint Application

While in certain industries, particularly the public-service-vehicle industry, brush painting is still very widely employed, the majority of industrial painting, particularly on mass-produced articles, is now applied either by dipping or by spraying. Since both dip painting and spray painting are widely known, it is not our present intention to deal in any detail with these methods which in any case were dealt with in some detail in the previously mentioned paper. It should, however, be stressed that with dip coating it is necessary to have slow immersion and withdrawal rates and, furthermore, particularly with automatic plants care must be exercised in jigging the work being painted to ensure adequate drainage and to avoid air traps when the work is immersed, since such air traps will, without doubt, leave a bare patch on the finished surface. The slow withdrawal ensures a minimum of drainage since advantage is taken of the surface tension of the paint tank to drag off excess paint as the part emerges through the paint surface.

It is also necessary to have means of agitation, particularly where tanks of large size are employed, and the normal method employed is to use a screw or positive-displacement pattern pump as the circulator, drawing from a low level in the paint dip tank and delivering to a storage tank, the paint then running by gravity back to the paint dip tank. If the tank width is large then it is desirable that the discharge branch should extend across the width of the work, with drilled holes to equalize the flow. Furthermore, the delivery from the paint storage tank should be well below the paint level in order to avoid aeration, solvent loss and frothing and, in the authors' opinion, the paint flow should be contra-flow to the work for very obvious reasons.

Normally dipping viscosities are higher than those used for spray coatings but will, of course, depend on the type of paint being applied.

Normal methods of spray painting are so well known that it is not proposed to spend any time in describing this system. In effect, the spray gun, which can be fed from a gravity or pressure pot or syphon cup on the paint side receives an air supply at appropriate pressure and atomizes the paint into a fine spray, the form of spray being a function of the type of nozzle employed, and this in turn being determined by the type of part to be coated. Needless to say, it is essential that the air supply shall be moisture free, also free of oil, and all spray painting equipment should be fitted with an efficient strainer to remove the oil mist carried over from the compressing stage and water which will condense out, particularly where a reduction between line pressure and operating pressure is employed.

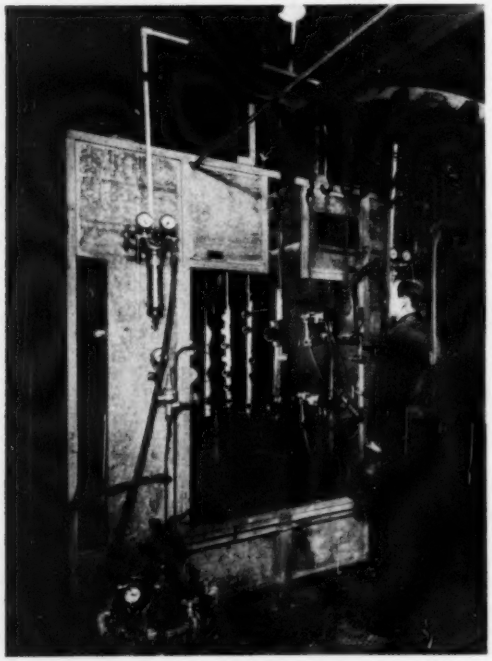
In regard to paint spray booths, until fairly recently these were all of the dry type and comprised essentially a sheet-metal casing with some form of baffle at the back or at the top of the booth, and were provided with a propeller-type extract fan which drew the paint-laden air from the spraying area and discharged this to atmosphere. It should be appreciated that it is not unusual for up to 60 per cent of the paint passing from the gun to be discharged to outside atmosphere and it is, therefore, very necessary to employ filters in the exhaust from the spray booth to prevent the discharge of paint to the surrounding atmosphere. Such filters can be constructed using coke-breeze or wood-wool with fairly satis-

factory results, though frequent maintenance is essential.

In recent years the tendency increasingly has been for spray booths to be of the wet-back pattern, and very many desgins are now in existence and in which, before the exhaust air is discharged to atmosphere, it is made to pass through a water curtain or a water spray to remove the paint carried over from the spraying process. Such spray booths generally employ a circulating pump to provide the water curtain and spray system and are normally provided with some form of filter to retain the paint deposit and to prevent this being carried to the pump and spray pipes. Many ingenious forms of sludge collection have been developed, some of them of the self-acting pattern and the use of continuous paper filtration which has been mentioned in connexion with phosphate processes is also now finding favour in booths of this type.

The tendency, particularly in large conveyorized booths, is for these to be of the down-draught pattern, that is the air being drawn through the floor of the spraying area or booth, and impinging on a wetted floor or passing through water sprays before being discharged to atmosphere. A very recent development of such a system is that employing high-velocity extract slots and such booths

Fig. 5.—Electrostatic spray booth using Ransburg No. 1 process. Components are rotated through electrostatic field.



are provided with enclosed sides only and no top, with extremely good results, the system of extraction being not dissimilar to that previously described for lip extraction on heated tanks. With this type of booth, and under working conditions and when handling fairly heavy paint volumes, there is no appreciable build up of paint on the surrounding floor area, even after long working periods, and the great advantage is that bulky loads which require to be handled by overhead-cranage can be accommodated quite simply.

A further development is a wet-type spray booth which does not employ a circulating pump, but which relies solely on the depression created by the extract fan to form water waves in the collection area and through which the air has to pass, these water waves being generated by means of special deflectors in the back of the booth. Eliminator plates are provided to remove any water carry over and the type of fan employed is either a cased centrifugal type, or an axial flow fan capable of developing the adequate depression which is generally of the order of 3 in. w.g. Extremely satisfactory results have been obtained with this type of booth which, although requiring a greater fan horsepower, does not use any external energy for water circulation.

Electrostatic Spraying

In recent years electrostatic spraying has found its own place in the finishing field, the basis being the well known principle of the discharge and attraction of ions of opposite charge ; this system has been very widely used for many years in the collection of dust by electrostatic precipitation.

Broadly the application of electrostatic spraying or painting is that the components are earthed, generally to the conveyor, which takes them into a highly ionized field produced by a grid surrounding the part and carrying a negative static pressure of about 100,000 volts. Into this field is sprayed the coating material, the finely divided paint particles picking up electrons which are discharged from the negative electrode and which are strongly attracted by the earthed work as it passes through the field.

Paint savings of the order of 50 per cent are claimed for this method of painting, but it must be strongly emphasized that the successful application of electrostatic spraying requires the right type of part for the continuous flow of generally similar articles. Furthermore, with the method just described and known as the No. 1 process, it may be necessary to rotate the parts as they pass through the field.

A development of the No. 1 electrostatic method is known as the No. 2 process, in this in place of spray guns of conventional pattern, the paint to be applied is pumped into a spinning cup running at

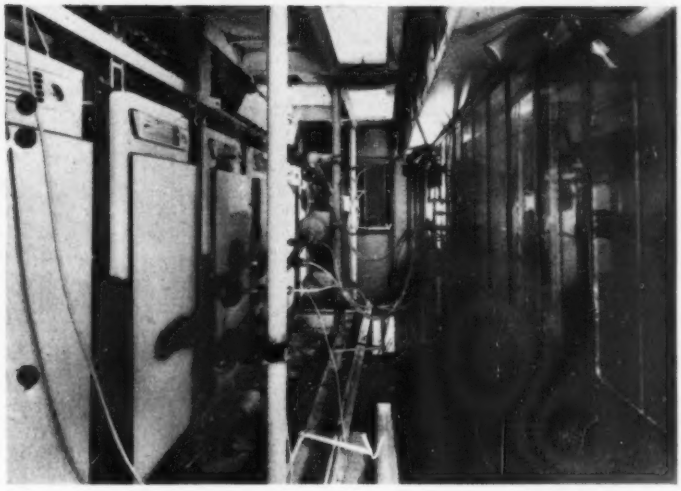


Fig. 6 (left).—Electrostatic spray booth using No. 2 (Spinning Cup) process on refrigerator finishing line.

Fig. 7 (below).—Electrostatic spray booth using Ransburg reciprocating disc on refrigerator finishing line. View shows bell at the outgoing end of the loop to finish off the top of the refrigerator which is hung in the inverted position.

approximately 1000 r.p.m. being flung off into the field in a finely divided state, and ionized as it leaves the spinning cup and thus attracted to the earthed component. By careful arrangement of the cups complete coverage can be assured, an advantage being that parts with deep returns can be coated.

Providing that great care is taken in the positioning of the cups, a uniform paint film is applied with a consistancy of finish which so far has not been attained with other methods of paint application, and the overspray, providing jigging has been carefully studied, is very small.

A further development, known as the Modified No. 2 process employs in place of the spinning cup, a rotating disc arranged on the centre of a loop formed in the conveyor system, the disc rotating at a similar speed to the cups just described and being attached to a reciprocating ram. The paint is fed to the centre of the disc and flung off in an ionized state, as in the case of the No. 2 process. The parts to be painted can be either continuously rotated in their path around the loop or can be indexed in the case of rectangular articles, and this particular method of electrostatic painting is finding increasing use in industry.

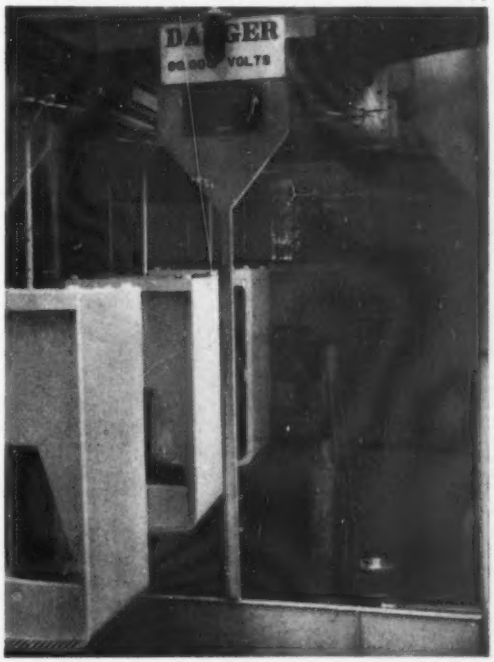
Before leaving electrostatic painting the newest development should be briefly touched on, that is a hand spray gun of special form and with suitable field attachment and which is now being used in this country and with very great economies over ordinary hand spraying methods.

Hot Spraying

Hot-spraying is similar to conventional cold-spray application except that the paint is heated before reaching the spray gun generally to temperatures of order of 160 to 180°F. ; this means that far less solvent is used in the paint formulation and in consequence, it is claimed much heavier coats can be applied without the danger of sagging troubles.

Airless Spray

Within the last year or so a new development of the hot spraying method, known as " airless spraying " has been introduced in this country,

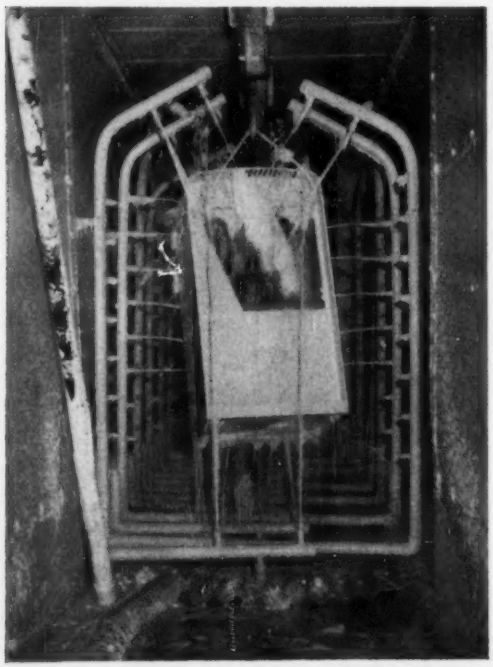


though this method has been, in recent times, extensively used in the United States. The system is based on the fact that a sudden release of hydraulic pressure through a properly designed restrictive orifice will break up a heated liquid into small particles. With such a system heat is necessary to lower the viscosity of heavy-bodied paints to a watery consistency to enable a build up of vapour pressure to bring part of the solvent in the paint to a partial boiling point, (since the liquid is under pressure the solvents do not, of course, actually boil). Upon the release to atmosphere of the mixture there is an immediate change of state from liquid to gas and this vaporization plus the high fluid pressure employed, between 300 and 600 lb. per square inch, results in complete atomization.

In essence the equipment comprises a high-pressure pump which syphons the paint from the container and at the generated pressure delivers it through heating coils, the paint being continuously circulated so that at all times hot material is available at the gun.

The angle of spray and the volume are controlled entirely by the type of nozzle employed, and while the paint particles leave the gun at high velocity, by virtue of their small mass they can only travel a comparatively short distance.

Fig. 8.—Flow coating unit used in the prime coat painting of refrigerator cabinets and components.



It is claimed for this system that because of the absence of compressed air as the atomizing agent, there is no rebound even when spraying into a trapped area. Further, chilling of the paint particles does not occur and thus they reach the surface to be painted in a hot state resulting in better bond and adhesion to the base metal.

"Roto-Dip" Process

The most interesting development which has received much publicity in recent years is the "Roto-Dip" process in which car bodies are suspended from a spit passing through the body and which is in turn placed on a specially designed conveyor, the spit with the body engaging in a rack during its passage through the various cleaning and drying stages and being caused to rotate so that all surfaces are not only adequately cleaned but since the body is also rotated through the paint tank, an even continuous paint film is ensured with a complete absence of air trapping. The paint and chemical volumes employed in such plants are very large, and in consequence need adequate supervision to ensure perfect operating conditions, but none the less a number of plants of very large size have been built and are working extremely well in the motorcar industry.

Flow Painting

In order to avoid the troubles associated with large paint volumes in open-top dip tanks, flow painting is now being considered for a number of applications where dipping or spraying would previously have been used. In essence flow painting comprises a flow section not dissimilar from the spray section of a continuous jet cleaning plant, spray nozzles being arranged round the work space so that the paint jets hit all the surfaces to be coated. As in the case of spray cleaning plant, generally the work-piece is suspended from a monorail type conveyor and is conveyed through the flow coat section, the coating rings with nozzles being disposed to ensure complete coverage of the work-piece and the painting time in the flow-coat chamber proper can be as little as 30 seconds up to a high limit of 2 minutes.

Paint is fed to the flow-coat rings by means of a positive-displacement or screw-type pump, drawing its supply from a paint tank which should have a capacity of not less than 3-minutes maximum pump capacity, this being necessary in order to allow the paint to rid itself of air bubbles picked up after its discharge from the flow-coating rings. Sometimes it is found desirable to arrange for baffle plates in the tank in order to provide for the longest path of travel from the return point from the flow-coat section to the pump suction. In the majority of plants, both in this country and in

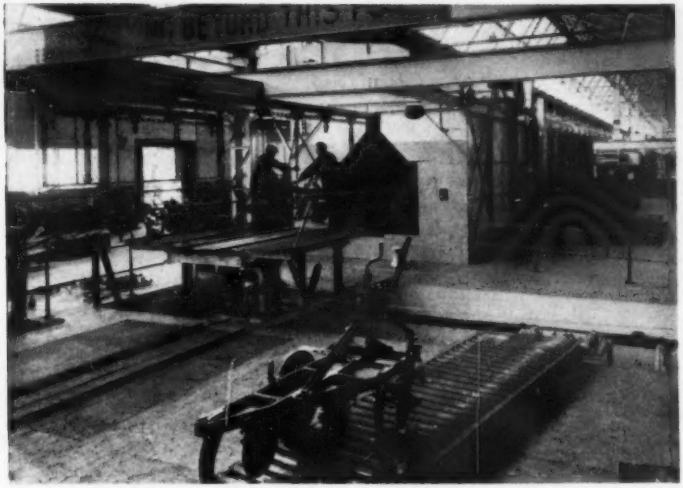


Fig. 9 (left).—View of flow coating unit used for the painting of agricultural implements. Photograph illustrates method of attaching implements to painting conveyor.

Fig. 10 (below).—View of double-sided coating machine for the continuous painting of steel strip, capable of handling strip up to 18 in. wide and for conventional or reverse coating, and with built in hydraulic tension unit.

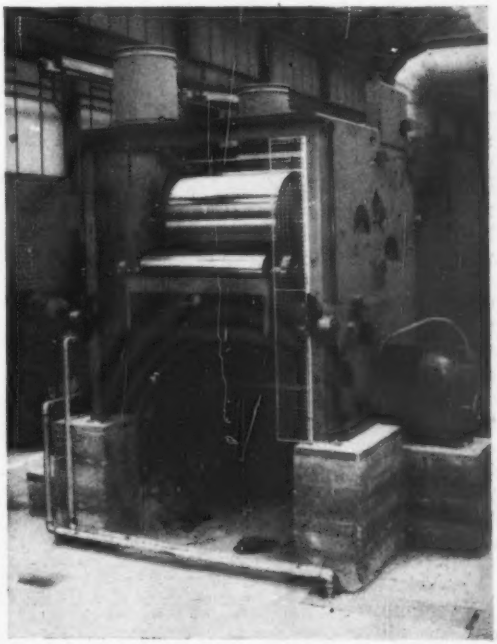
America, two paint tanks are employed, one containing the paint being used at any one time, the second being used as a stand-by tank ; normally in addition to the paint tanks, a solvent tank is provided, the three tanks being interconnected with the pump and pipework system and suitably valved. At the end of a run the paint circulating system is shut off and solvent passes through the pump and pipework and through the flow-coating chamber in order to clean this down.

For the majority of work it is essential that after leaving the flow-coat chamber proper an enclosed vapour-laden enclosure is provided through which the work-piece passes for draining and the purpose of the vapour concentration is to ensure that the paint remains open, though care must be taken to see that the solvent concentration does not approach a point where solvent washing of the work-piece will occur. Furthermore it is necessary, in order to prevent the escape of solvent to the surrounding shop area, for seals to be provided at both entering and exit points from the flow-coat unit, and it goes without saying that the draining angles, particularly in the flow-coat chamber, should be adequate to ensure rapid and free drainage of the paint back to the working sump.

It should be stressed that any flow-coat unit will be mainly dependent for its efficient operation on the correct formulation of the paint being used—this was not appreciated in the early days of flow-coating installations, both in America and this country, and incorrect paint in a flow-coating unit can give extreme trouble.

Briefly, paint used in a flow-coating unit should not only have the characteristic of remaining open for a considerable time after application in order to provide for flow-out and drainage but must also have the characteristic of readily losing the air which will be picked up both through the circulating system and after it leaves the flow-coating jets. Furthermore, in order to reduce the solvent loss, the correct type of solvent which should preferably have a high boiling point must be utilized.

In plants with which the authors have been associated it has been found that the ratio of solvent loss to paint usage can be as low as $2\frac{1}{2}$: 1 with



a high level of 4½ : 1 but it must be appreciated that the solvent is considerably cheaper than paint and furthermore virtually no labour is employed in the operation of a flow-coating installation. Without doubt this method of application has come to stay and will find increasing use though it must be stressed that, as with all paint application methods, this is just one more tool available to Industry.

A further method of paint application which should be touched on and which has been widely used in the metal-box industry is roller coating, in which the coating material is applied by means of rollers to a flat sheet ; the paint or varnish film is then dried and the flat sheet formed to the desired shape.

Roller coating is probably the most efficient method of paint application since film thickness can be controlled accurately and there is virtually no paint wastage, and this method of coating is now being applied in the manufacture of oil drums up to the well-known 40-gallon size.

A further development of roller coating is now being installed in this country and which enables paint to be applied at one pass to both sides of steel strip which is being continuously passed through the plant. Special coating machines have been developed and are used for this process. Strip speeds of up to 100ft. per minute are quite commonly used in the U.S.A. and plants are working in the Walsall and Birmingham areas, capable of coating both sides of steel strip up to 0.048 in. and at speeds of 60 ft. per minute.

The most modern method of paint application and which has only just been introduced into industry in this country is know as " curtain " coating. This in effect comprises a machine through which the work-piece, which at the present stage of development must be flat in form, is passed on a conveyor system paint being fed to the sheet as it passes through the machine by means of a specially designed and accurately controlled slot in a paint container, which is under a slight pressure to give a cushion effect and also to ensure that the paint volume is constant for the full width of the slot. The film thickness is a function of the speed with which the sheet passes through the machine and also the width of slot employed, and this method of painting is now finding a very wide use particularly in the wood finishing industry, though for sheet metal so far the use has been comparatively limited due to the necessity for very high speeds through the coating machine, which do provide a drying problem.

Stoving

There are two schools of thought on the vexed question of stoving.

The two forms of heating in universal use are the so-called infra-red or radiant method, and convection stoving.

Radiant heating, which can utilize town gas or electricity as the heat source comprises a radiant body working at elevated temperature and directing streams of heat energy at the work to be processed.

In the case of the electric radiant equipment which can be either in the form of specially designed lamps or radiant elements—either of the bright or dull element type—the lamps or elements are built round the conveyor system and arranged to heat all surfaces of the work to be dried.

In the case of the gas-fired equipment, the early form of radiant comprised a circular tunnel, the outer casing being insulated with a gas passage between an inner sheet-metal radiating surface, gas jets being provided at the lower edge and on both sides of the tunnel to heat the inner radiant face. The more modern form of gas-fired radiant tunnel comprises refractory or cast-iron block behind which are gas jets to provide a high surface temperature the panels being, as in the case of the electric radiant panels, sited to strike all surfaces of the work to be dried.

Radiant energy is projected in a straight line and thus areas of an article more distant from the heat source must of necessity receive a different heat treatment condition than nearer areas. Variations in thickness of the work will result in different surface temperatures, and thus a variation in the heat treatment condition, and furthermore if a part is shielded from the radiant panel then it can only be heated by convection currents which are present in the tunnel or by conduction through the metal itself.

While radiant equipment has, in the last few years, been widely used in industry, its greatest use has been found to be where line production is in being and a constant flow of work of similar kind and constant section is being processed. If there is a large variation in shape and thickness on the production line, then almost certainly trouble can be experienced in obtaining constant stoving conditions and it may be necessary to batch work and adjust panel temperatures and conveyor speeds to suit variations in size and section.

Convection methods can be divided into two classes, one the older natural convection system which in its crudest form comprises an insulated casing containing burners or heating elements, generally located in the bottom of the stove, the heating being accomplished by the natural flow of hot air from bottom to top of the chamber. With such a system a large temperature variation must of necessity exist and furthermore a large proportion of the heat received by the parts being

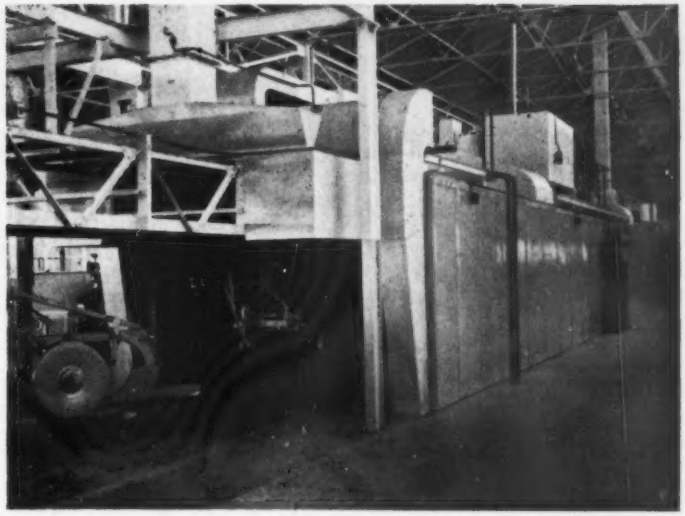


Fig. 11.—Discharge end of through type gas fired, air circulated oven showing air seals. Oven has a length of 75 ft. a width of 9 ft., and operates at 275°F.

dried is from the radiant effect from the inner wall of the stove.

Paint formulations demand equality of temperature for constant results and in an endeavour to avoid some of the disadvantages present with the natural convection system, the triple-cased stove was evolved which essentially was similar to the double-cased stove just described, but contained an inner mild-steel casing. Gases are circulated in the intervening space, vents being provided to both gas spaces and to the inner casing in order to evacuate combustion products and also the solvents given off during the drying operation. Almost all the disadvantages pertaining to the double-cased stove also apply to the triple-cased unit which is, in effect, a crude form of radiant dryer, since the whole of the heat energy received by the working space is radiated from the walls of the inner casing.

To obtain satisfactory results from such stoves, it is necessary to work at comparatively low temperatures and to place the work-piece carefully in order to avoid over or under stoving and such methods result in extremely long drying times.

Modern development is to use the fully recirculated or air circulated stove and which is sometimes known as a forced convection stove in which the heat source is remote from the work space in order to avoid troubles due to radiation. The heating medium is air and/or the products

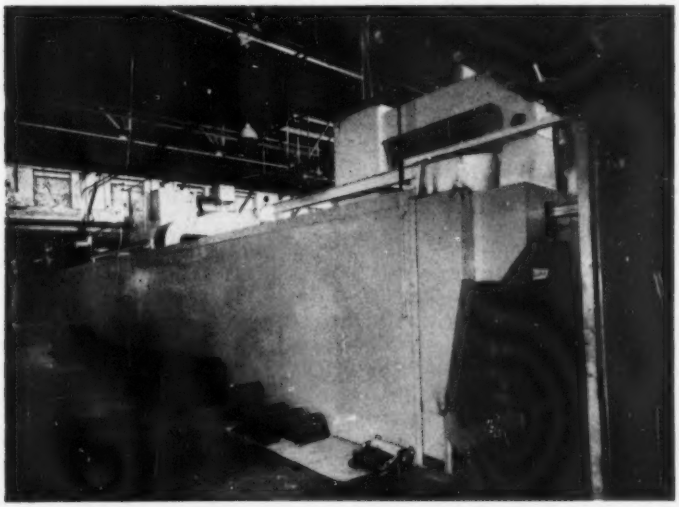


Fig. 12.—View of "U" type gas fired, air circulated oven used for the stoving of lawn mower components, and showing air seals at the entry/discharge points.

of combustion which are circulated by means of a centrifugal or axial-flow type fan coupled to the combustion chamber or heater battery. In order to conserve heat and ensure a thermally efficient unit recirculation is employed, that is a connexion is taken from the work space back to the heat sources, the air having given up its useful heat to the work space being returned to the source for re-heating. It is essential, of course, where solvents are given off during the drying operation, to allow a degree of venting in order to avoid a build up of explosive vapour, and for this purpose a ventilating stack is provided and in the case of electric or steam heating a corresponding fresh-air intake system. In the case of gaseous fuel the fresh air inlet is generally through the front of the combustion chamber.

Providing the system is well designed and the fan is of adequate size, then it can be said that virtually the whole of the work space can be of the same temperature within very close limits, since a high degree of turbulence will exist to break down stratification and if the fan size has been correctly calculated then the temperature head of the incoming air will be only slightly above the control temperature. A well-designed air-circulated system will give stoving rates approaching those to be met with radiant equipment and without the disadvantages of high working temperatures, since the control can be set to operate below the spoiling temperature of the work being processed. Furthermore, mixed batches of work can be handled with a consistancy of finish and, with the turbulent atmosphere that exists, parts of very intricate shape can be said to receive identical heat treatment conditions. Again high density loading can be employed since there is no shadowing effect with an air-circulated oven as obtains with radiant methods.

It may be of interest to note that in the case of the continuous strip finishing lines, which were briefly touched on under the heading "Roller Coating," radiant methods have been found to be completely impracticable and the stoving of the painted strip, both in this country and in the U.S.A. is invariably carried out in an air-circulated oven, and stoving times of 1 minute or less are commonly employed on lines of this type.

Conventional forms of forced air circulated stoves vary from small batch-type units, used for laboratory purposes, up to extremely large installations of the conveyor pattern. Where line-production methods exist then it is possible to continue a monorail conveyor system through both pretreatment, paint application and final drying, stoves generally employed with monorail systems being of the through or 'U' type though the familiar camel back or 'A' type oven can also be built with a monorail conveyor system.

Where the end opening is required to be of large proportions then generally an air curtain is provided at both entering and exit ends in order to avoid the cold convection condition which will obtain and which results in spillage of hot air to the shop and consequent loss of thermal efficiency in the stoving unit. Air curtains are of varying forms but in principle comprise high-velocity air nozzles arranged at both sides and sometimes at the bottom of loading and discharge openings, and designed to project streams of air across the opening. A bleed connexion is generally taken from the working chamber and the air from the air curtain is collected in a hood and partially recirculated.

With through-type ovens it is generally considered that at least 25 per cent. of the total length of the stove is ineffective due to end losses, this ineffective length varying with the size of opening and the degree of silhouetting which can be obtained. Through-type ovens are sometimes used with slat conveyors.

'A'-type or camel-back ovens generally employ a flight-bar conveyor system in order to obtain high-density loading, although as previously stated many such ovens are provided with mono-rail conveyors where the shop layout demands such a conveyor system. The advantage of the camel-back stove is its self-sealing feature with consequent economy in running consumption, the heat source being generally located below the bottom of the stove. In all well-designed forced air circulated systems recirculation is invariably employed, and in the camel-back design and at the loading and is provided an exhaust fan which has two functions, one to remove solvent from the work space as this is given off by the cold work as it reaches the heated zone, and, secondly, to create a seal at the entering lip, the air removed in a fume-laden condition being replaced at the unloading and thus creating a seal at this end also. The effective length of an 'A'-type oven is normally considered to be that portion in the apex.

The subject of this paper is very wide in its scope and, in consequence, it has been possible only to give a very brief summary of the many processes and forms of plant which are used for industrial finishing. Furthermore, it has been necessary to limit the remarks on the finishing side of the paper to paints and similar coatings and, in consequence, it has not been possible to deal with vitreous coatings nor metal spraying techniques, nor indeed with galvanizing equipment, all of which have their place in the finishing field.

A CHEMICAL TREATMENT AGAINST CORROSION OF GALVANIZED STEEL PRODUCED IN CONTINUOUS LINES

by G. ODONE* and G. MILANESE†

THE preservation of the superficial characteristics of brilliance and corrosion resistance of galvanized steel, both in coil and in sheet form, has always been a problem for both producers and users.

In other words, the authors refer to the objectionable phenomenon of " white rust " which is easily formed on the surfaces of galvanized coils and sheets under uncontrolled conditions of temperature and humidity.

White rust is a zinc corrosion product and is damaging under many aspects, with consequential depreciation of the product and a reduced electrochemical protection of the steel base.

In many galvanizing lines, appropriate chemical and electrochemical treatments are used with varying success to prevent or eliminate this defect. These treatments vary among themselves according to the type of equipment, storage conditions and other factors.

The authors are aware of the many difficulties encountered by many producers and users of galvanized steel connected with the formation of white rust on stored coils and sheets under uncontrolled atmospheric conditions and as a result of an investigation it has been possible to study the behaviour and the resistance to corrosion of galvanized steel and a suitable treatment bath has been evolved which has given optimum results for over a year.

The use of this bath preserves the original brilliance of the galvanized coating and retards the formation of white rust on the surfaces of galvanized coils and sheets, even after many months of storage under uncontrolled ambiental conditions of temperature and humidity.

1. General Considerations Regarding Corrosion Resistance Behaviour of Galvanized Steel

It is known that the main factors which determine the preferred use of galvanized steel as compared to steels with other metallic coatings is the anodic behaviour of the zinc with respect to steel. This behaviour is present even in the presence of localized zinc removal such as scratches, marks and so forth. As a result, if the corrosion problem can be retarded or prevented by some means, the electrochemical protection will be greater as a function of the time.

The formation of white rust which was mentioned above is damaging because it extracts zinc from the coating and converts it into basic carbonates of zinc of variable composition, thus shortening the life of the ferro-zinc couple[1] [2] [3] [4]. This formation is brought about by complex chemical reactions and electrochemical phenomena with the presence of oxygen and atmospheric humidity, and by various aggressive ions.

Concerning the particular case of galvanized coils and sheets stored in warehouses under uncontrolled conditions of humidity and temperature, the factor mostly responsible for the corrosion is the differential oxygenation, that is, the formation of local couples of oxygen concentration. This phenomenon is well known in electrochemistry, and, therefore, the complex theory is omitted.[4] Furthermore, the problem of white rust formation on galvanized steel is very much worsened when this is stored in warehouses close to the sea. The marine atmosphere, due to its chloride content, is particularly aggressive and, therefore, the action of the latter is added to that of the general corrosion factors.

The effort of galvanized steel producers to eliminate or retard this damaging phenomenon, is therefore, understandable.

2. Protection of Galvanized Steel against Corrosion

In order to achieve an efficient protection against the formation of white rust, many producers make use of chemical treatments known as passivation processes. It is not considered appropriate, at this stage, to discuss the theory of the passive state of metals, because it appears that this problem is impossible or, at least, difficult to state completely.

*Research and Quality Control Superintendent.
†Chief Chemist — Research Department Cornigliano S.p.A. Genoa-Italy.

Chemical, physical-chemical and electrochemical factors are involved[5] [6] : for instance, the presence of certain anions of oxygenated acids ; the presence of small quantities of acids which act as reaction activators[7] : and the increase of the metal's potential in the electromotive series in the direction of the noble metals.

Many authors who have studied this problem from the theoretical point of view (*Müller, Hedges, Evans*) agree on the basis of their results on a probable existence of an oxide film on the metal surface. Furthermore, contrary to the line of thought of the first investigators who studied this problem, the presence of the passive state is connected with very thin protective layers which are continuous and which adhere to the base metal.

For the passivation of galvanized steel it is necessary to obtain passive layers presenting the characteristics mentioned above.

In practice, many producers employ oxidizing agents, especially hexavalent chromium compounds, *i.e.* $CrO_4^{=}$ anions : chromic acid, chromates or dichromates.

In addition to the various formulations of practical use which are kept secret by the trade, and in addition to the various patented processes, there are valuable works of technical literature on the subject which, however, in the authors' opinion, do not give the galvanized steel producers a guide and positive criterion for the solution of the corrosive problem.

This is because the passivation of galvanized steel has to be separately studied for almost every single product category and its end use.

Consequently, the analyses to be executed for a passivation test, aside from certain laboratory tests of general nature, must necessarily keep account of the type of the product and its end use.

In the present research, these factors have been kept in mind, therefore, after a preliminary laboratory examination of various passivating solutions, practical tests on galvanized steel lifts of commercial dimensions were initiated under actual conditions of exposure in a storage warehouse without particular atmospheric control for humidity and temperature.

3. Research and Experiment on a Passivating Solution

3.1. *Laboratory Tests.*

The authors' plant produces galvanized steel by means of the Sendzimir process. For the continuous galvanizing process it was necessary to study a bath of easy application and which did not require substantial changes or additional equipment on the already complicated line.

The various bath compositions first studied before passing to practical tests on the line, were partially obtained from the technical literature[8] ; others were specialy formulated and included the one that was finally adopted.

The tests indicated the importance of the addition of small quantities of wetting agents to the passivating bath. These latter, decreasing

Fig. 1.—(*a*) *untreated sample ;* (*b*) *to* (*h*) *samples treated in solutions* 1 *to* 7 *respectively.*

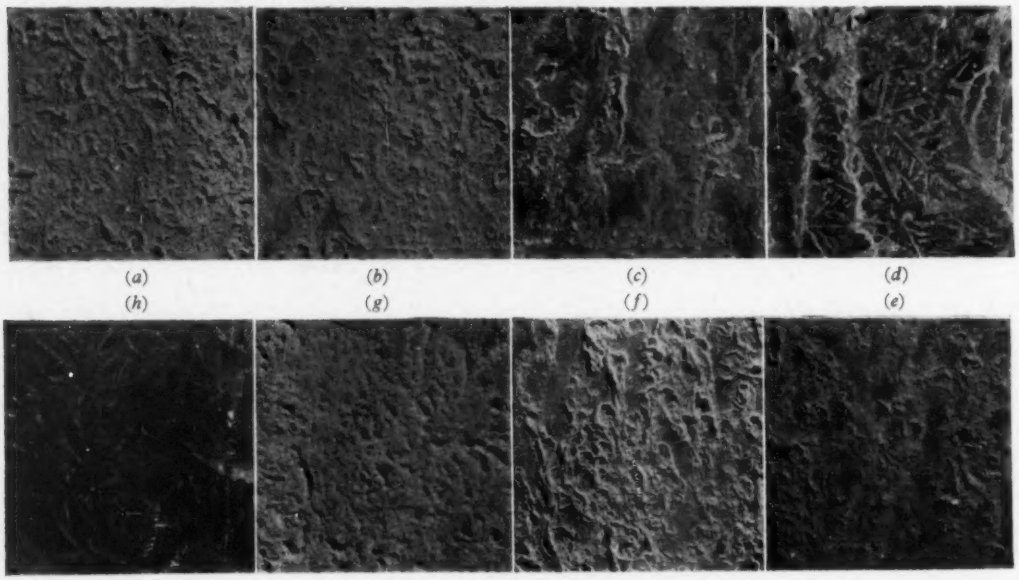


Table I.

Passivating Solutions Tested in Laboratory

Number of solution	Composition of solution		Sample aspect after treatment.
1	Chromium Trioxide Conc. Sulphuric Acid	10 gm./l 0.1 ml./l	Satisfactory
2	Chromium Trioxide Conc. Sulphuric Acid	10 gm./l 0.2 ml./l	Not satisfactory Brown spots on the surface
3	Chromium Trioxide Conc. Sulphuric Acid	10 gm./l 0.3 ml./l	Not satisfactory Brown spots and little etching of the surface
4	Sodium Dichromate Conc. Sulphuric Acid Wetting Agent	20 gm./l 1 ml./l 0.5 ml./l	Satisfactory
5	Sodium Dichromate Conc. Sulphuric Acid	20 gm./l 2 ml./l	Not satisfactory. Spots and etching of the surface
6	Chromium Trioxide Wetting Agent	10 gm./l 0.5 ml./l	Satisfactory
7	Chromium Trioxide Conc. Sulphuric Acid Wetting Agent	10 gm./l 0.1 ml./l 0.3 ml./l	Satisfactory

the solid-liquid interfacial tension (*i.e.* between the galvanized surface and the passivating solution) bring about a uniform wetting of the surface by the passivating solution and, consequently, a uniform reaction is obtained.

The use of wetting agents does not disturb the chemical balance of the passivating solution because they are stable in a wide *p*H range.

Various solutions tested are listed in Table I. Galvanized panels with coating weight of 1 oz. per sq. ft. were used. The samples were rinsed in acetone to remove any trace of oil ; dipped in a beaker containing the solution to be tested (Temperature : 176°F — Time : 5 seconds) ; and finally squeegeed between two rubber rolls and perfectly dried.

A difference was noted between the wetting capacity of some solutions and that of others ; greatest consideration was given to the final appearance of the samples in regards to brilliance and eventual surface alterations, as chemical etchings or colour changes.

It was thus possible to form a summary opinion as regards the appearance of the passivated panels, classifying them as " satisfactory " or " not satisfactory." These treated panels were subjected to preliminary laboratory tests under particularly aggravated conditions in order to decide which of the solutions tested could be further considered for practical application in the galvanizing line. Following are the tests performed :—

(a) Salt spray fog test, A.S.T.M., with sodium chloride (5 per cent) in distilled water. [9]

(b) Total immersion in artifiicial sea water at room temperature in accordance with a known technique derived from the literature on the subject[10] This solution, in the authors' experience, is " aggressive " to a maximum degree.

The laboratory test results are listed as follows. In Table II, are recorded the observations of the specimens after 32 hours of salt fog test, divided into four periods of eight hours each with spray and four periods of sixteen hours each without spray.

In Fig. 1 are shown photographs of the panels after test.

Figs. 2 and 3 show the results of the total immersion test. By examination of the time-weight loss curves, a surprisingly good correlation is noted to take place with the salt-spray test listed in Table II.

Fig. 2.—Graphs of weight loss v. immersion time for untreated sample and samples after immersion in solutions 1 to 7.

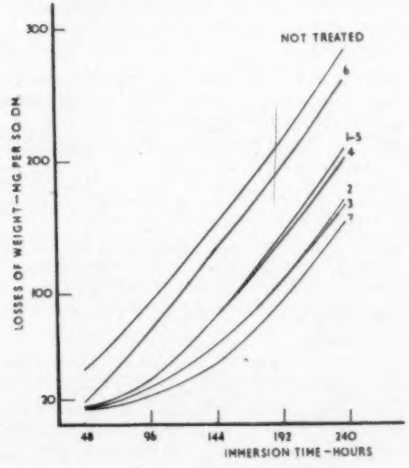


Fig. 3.—Diagram showing weight loss in solutions 1 to 7.

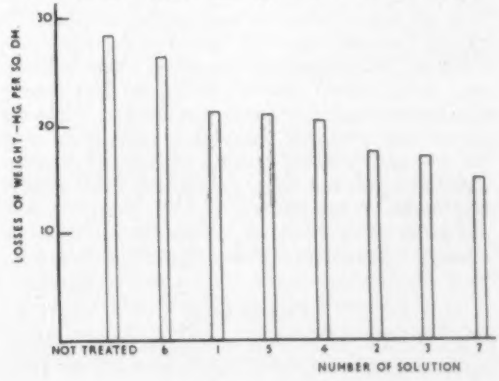


Table II.

Observations on treated panels after salt spray fog test A.S.T.M.

Number of solution	Sample aspect after fog test
Not treated panel	Complete white corrosion
1	Complete white corrosion
2	Little unetched remaining areas
3	Corroded edges
4	Little unetched remaining areas
5	Little unetched remaining areas
6	Complete white corrosion
7	Beginning of corrosion at edges

3.2. *Practical Tests.*

By using a simple equipment existing in the galvanizing line, passivating runs were initiated by using solution no.7 (CrO_3 10 gm. per l. — Conc. H_2SO_4 0.1 ml. per l. — w.a. 0.3 ml. per l).

Right from the start, results were satisfactory, to the point that it was decided to adopt the use of this solution on a production basis. For the practical evaluation of the results, it was decided to store the galvanized material in a warehouse which was formerly considered inadequate because galvanized materials stored in it used to oxidize rapidly because of the high humidity and the wide temperature range. This warehouse is only partially closed without aeration or temperature conditioning equipment ; furthermore, due to its closeness to the sea, its atmosphere normally contains chlorides, particularly during the days in which the wind blows from the sea. The location, furthermore, situated in a valley, favours the gathering and conservation of a high humidity.

In Fig. 4 are depicted the curves of relative humidity and temperature of this warehouse. As can be observed, the conditions are particularly unfavourable for the storage of galvanized coils and sheets.

Nevertheless, the brilliant aspect remains unchanged without any surface damage.

Using the solution mentioned no cases of white rust have since been observed in the above-mentioned warehouse or in any other ; nor have there been any complaints from the trade even for material stored for long periods of time in client's warehouses under particularly unfavourable conditions. The authors do not offer customers any suggestions or precautionary measures to be taken for the storage of their galvanized products.

Conclusions

By means of this investigation the authors' experimented with a passivating bath of great efficiency, of easy preparation and application, and with good protective properties for the prevention of white rusting on galvanized sheets and coils. The optimum results are confirmed by more than a year of practical application on a continuous galvanizing line.

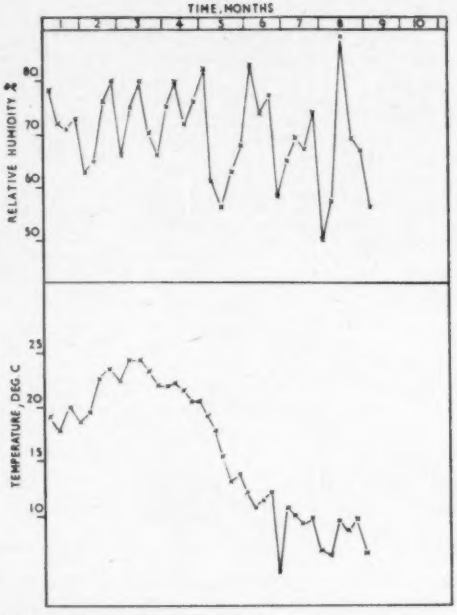


Fig. 4.—Graphs showing variation in relative humidity and temperature of warehouse.

Aknowledgements

The authors extend their gratitude and thanks to the management of the Cornigliano S.p.a. for the permission to publish this paper.

References

(1) Stiching Doelmatig Verzinken " De Corrosieweerstand van Thermisch Verzinkte Staalconstructies " — 1955.

(2) Hoover, G. R. and Thomas, A., " Causes and Control of White Rusting on Zinc-coated Sheets," 1949 Regional Technical Meeting of A.I.S.I.

(3) Gilbert, P. T., " The Nature of Zinc Corrosion Products " Report R.R.A. 855. *Journal of Eletrochemical Society*, 1952 **90**, pp. 16-21.

(4) Gilbert, P. T. and Hadden, S. E., " White Rust Formation on Zinc." *Journal Institute of Metals*, 1950, **78**, part 1.

(5) Glasstone, S., " An Introduction to Electrochemistry," 5th print, D. Van Nostrand Co., New York (1951).

(6) Uhlig, H. H., " The Corrosion Handbook, " J. Wiley & Sons, New York, 1955.

(7) *Metal Finishing* — 21st Guidebook Directory 1953.

(8) Biestek, T., " Essais de corrosion accélerés de revêtements électrolytiques de zinc sir acier, passives par la methode chimique "—*Corrosion et Anticorrosion*, 1958, pp. 59-65.

(9) A.S.T.M., B. 117, 54 T, 1955, part 2, pp. 871-878.

(10) Bubsey, F. J., " The Effects of Chromate Films on the Corrosion Resistance of Hot-dip Galvanize in Brine," *Metal Progress* 1954, May, **65**, pp. 122-124.

ZINC COATINGS ON IRON AND STEEL

1—The Problem of Corrosion and its Prevention

A Survey

by A. K. PARKER, M.A.
in collaboration with the Zinc Development Association

DURING 1958, over 20 million tons of iron and steel were used in the United Kingdom for the fabrication of a very wide range of products. All this metal had to be extracted from its ores by involved thermochemical processes to break down the chemical bonds between the iron and the other elements with which it is combined in nature. The comparatively pure metal so obtained, and put to such a wide range of applications, is unstable and immediately tends to react with its environment, in particular with oxygen in the atmosphere.

The reaction of an exposed ferrous surface with oxygen is popularly known as rusting and is a particular example of corrosion, the term used to describe the interaction of metals with their environment. Because the rusting of iron and similar corrosion processes are so readily observed and appear to involve little more than the combination of the metal with oxygen to yield a layer of metallic oxide, the complexity of the chemical processes tended to be obscured and it is only comparatively recently, as a result of intensive research, that a more complete understanding of them has been obtained.

The widespread occurrence and industrial significance of corrosion makes it a problem of great importance. A number of organizations are therefore undertaking research into its nature and methods for its prevention, the principal ones in the United Kingdom being the British Iron and Steel Research Association, the British Non-Ferrous Metals Research Association, the National Chemical Laboratory, the Admiralty and the Department of Metallurgy at Cambridge University, with the co-operation of many companies in the metal-using industries, some of the largest of which also carry out their own research work in this field.

For a proper appreciation of the various methods of combatting metallic corrosion, it is necessary to have some understanding of the nature of the corrosion processes. Their complexity makes it impossible to do more than give a very superficial account of them in the course of the present series of articles, and readers seeking a more complete account are referred to the works listed in the bibliography to be published at the end of the series.

Fundamentally, corrosion is an electrochemical process. That is to say, it is accompanied and accelerated by the passage of very small electric currents between the corroding metal and any other metal with which it is in electrical contact or between different areas on the surface of the corroding metal. For these currents to flow, it is necessary that a potential difference should exist either between the two pieces of metal or between the different parts of the same piece, and that moisture or other electrolyte should be present on the surface to act as a conductor for the current. Potential differences sufficient to cause current flow can arise from very small local variations in the chemical constitution of the surface : phase differences across a grain boundary, *e.g.*, between ferrite and pearlite or cementite, or between the basis metal and a sulphur or phosphorus inclusion are quite sufficient to constitute an electrolytic cell. Variations in the concentration of dissolved oxygen in the surface moisture also contribute to the electrochemical corrosion. The need for the presence of moisture during the corrosion process is demonstrated by the fact that, in very dry climates, *e.g.* in certain parts of India and Africa, iron articles of great antiquity have been found in a very good state of preservation. Since most corrosion is an oxidation process, the existence of a steady supply of oxygen at the surface of the metal is also necessary for corrosion to occur.

The electrolytic cells which are set up in this way comprise a series of positive anodes and negative cathodes between which currents flow and at which electrochemical reactions take place. The reactions at the cathodes may be regarded as electron-consuming and those at the anodes as electron-producing. The actual disintegration and corrosion are associated with loss of electrons and so occur at the positive anodic areas.

It would therefore appear that the simplest way of hindering the corrosion processes at a metal

FIG. IA.

ORE (= metals + other elements) —Extraction Process→ METAL (pure or nearly pure)

surface is to seal it off by an impermeable and adherent coating which prevents the access of moisture and oxygen. The criteria for the selection of a suitable material for use as a coating are sufficiently obvious. Such coatings need to be strongly resistant to the corrosive influence of their environment and sufficiently impermeable to prevent oxygen and water vapour penetrating to the metal surface. They also need to be tough, abrasion resistant, and to adhere strongly to the surface they are required to protect.

FIG Ib.

METAL + ENVIRONMENT (pure or nearly pure) —corrosion process→ CORROSION PRODUCT (= metal + other elements)

The application of a metallic coating to a metal surface considerably affects the type of electrolytic action which takes place. The direction of the current which flows when two metals are brought into contact in the presence of an electrolyte depends on the relative positions of the metals in the galvanic series, part of which is set out in Table I. The metals in this Table are listed in diminishing order of nobility, the most electro-positive metals being at the top and the most electro-negative at the bottom. Generally speaking, if two metals are in contact with each other in the presence of an electrolyte, a current will flow from the metal which is higher in the table to the one which is lower.

Hence if zinc and steel are in contact in the presence of an electrolyte, a current will flow from the steel to the zinc so that the zinc becomes an anodic electron-producing area while the steel is cathodic and electron-consuming. The zinc therefore corrodes in preference to the steel and, in so doing, protects the steel surface. This type of sacrificial or cathodic protection occurs when zinc coatings on steel surfaces are subjected to mechanical damage whereby the continuity of the zinc coating is broken and the steel surface is exposed.

Table I

METALS IN GALVANIC SERIES	
Monel Metal	Cathodic End (Electropositive)
Cupro-nickel	
Copper	
Brasses	
Nickel	
Tin	
Lead	
Cast Iron	
Steel	
Aluminium	
Zinc	(Electronegative)
Magnesium	Anodic End

This important property of zinc as a coating material, which, as will be seen from the list of metals in Table I, is also possessed, although to a lesser extent, by aluminium, gives it an important advantage as a coating metal over such metals as nickel and tin which are higher than steel in the galvanic series.

In the presence of certain electrolytes, the relative positions of some of the metals listed in Table I can be altered ; an important example occurs when tinned steel is in contact with fruit juice[2], in which case tin is anodic to the base metal. In general, however, the protection afforded by tin or nickel coatings on iron and steel is effective only so long as the coating is continuous and free from pores or other discontinuities. When there are breaks in the coating, electrolytic action between the coating and the basic metal accelerates the dissolution of the steel ; such dissolution can proceed at the steel surface underneath the cathodically-protected metallic coating until breakdown occurs over a large area.

With zinc or other electro-negative coating, a further protective action occurs at minor discontinuities in the coating as a result of the selective dissolution of the coating, since comparatively bulky corrosion products accumulate in the damaged area and tend to inhibit further electrochemical action there. Thus, in domestic water systems for which zinc is widely adopted as a protective coating, the sacrificial dissolution of the zinc at discontinuities in the coating in the presence of calcium bicarbonate (a normal constituent of hard water supplies), leads to the deposition of an in-

(*Continued in page* 245)

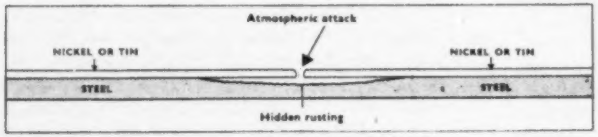


Fig. 2.

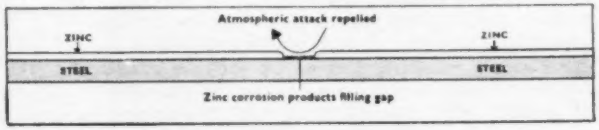


Fig. 3.

A Quarterly Survey of some of the Features in Finishing Literature from Abroad

by SCRUTATOR

JUDGING by correspondence in some Journals last year, the interpretation of information on the use of aluminium in American automobiles aroused considerable controversy. At the risk of starting another controversy however, it is worthwhile recording that the most recent ALCOA Report[1] states that if the anticipated 1959 production schedules are met the average usage of aluminium in new American cars will be approximately 51½ lb. per car. Of this 10 lb. per car will be in trim as compared with 9 lb. per car in 1958. With regard to individual Companies, the largest increase is shown by Ford where the average per car has risen from approximately 50 to 60 lb. and the cars containing the highest quantity of aluminium are those manufactured by Chrysler with an average of approximately 69 lb. per car.

Chromium Plating

Probably one of the simplest plating solutions as far as composition and control are concerned is that used for chromium plating. Two papers have recently been published dealing with the analysis for sulphate in such solutions. Dacey and McKinley[2] have demonstrated that errors can arise if samples of the plating solution are not first filtered before analysis within 1-1½ hours after removal of the solution from the plating bath. In their tests a solution from a production chromium plating tank was cooled to and maintained at 60°F. Samples were withdrawn at intervals, filtered to remove any insoluble sulphate and gravimetric determinations of sulphate made. Whereas the sample taken as soon as the solution temperature reached 60°F. had a sulphate content of 2.58 gm. per litre, that taken 6 hours later had a sulphate content of 2.46 gm. per litre. This decrease in sulphate was attributed to the presence of barium, calcium and/or lead, as the solubility of their sulphates decreases as the temperature is lowered.

The classical method for the determination of sulphate in a chromium plating solution is to precipitate as barium sulphate from the reduced solution, filter, ignite and weigh. A more simple, quicker and equally accurate method[3] is claimed to be to dissolve the precipitated barium sulphate in a measured excess of EDTA standard solution in the presence of ammonia followed by back titration with standard zinc chloride solution using Erio Chrom Black T Indicator.

It is a pity that these refinements have only been introduced now that the need for sulphate determinations is reduced due to an increasing use of sulphate regulating high speed baths !

Still on the subject of chromium plating, the first progress report[4] of Section F of the Plated Metal Coatings Committee of the A.S.T.M. has been published summarizing factors which influence the adhesion of organic coatings to chromium plated surfaces. This study was limited to clear organic coatings applied essentially to increase corrosion protection. They recommend that the final rinses after chromium plating should be with distilled or demineralized water and the organic material should be applied immediately after the plated surface is dry. Many platers will perhaps be somewhat astonished to learn that 2-4 hours exposure of the plated work to shop conditions before application of the lacquer was most detrimental to adhesion.

Adhesion was poorer to a chromium plate deposited directly on to copper than chromium plated over nickel. As a treatment to overcome variations from the ideal, it was recommended that chromium plated parts should be immersed in or sprayed with a solution containing 2-4 oz. of chromic acid per 100 gallons of demineralized water—identical with the chromate rinse solution used after phosphating—followed by a final rinse with demineralized water.

Corrosion Protection

Cash and Scheuerman[4] have described a cadmium plating process and control procedure which enables high strength steel for aircraft landing gears to be plated without embrittlement. As the amount of hydrogen required to embrittle high strength steel is extremely small, until a plating process is developed which is 100 per cent effective in preventing embrittlement anything which can be done to assist embrittlement relief must be of marked advantage. Porosity is one such factor and they have been able to develop a porous cadmium plate of satisfactory corrosion protection. Porosity is produced by an elimination of brighteners from a standard cyanide cadmium

(*Continued in page* 245)

NEW METAL-FINISHING LABORATORY

B.N.F.M.R.A. opens additional Research Block

SINCE the foundation of the British Non-Ferrous Metals Research Association nearly forty years ago, the scope and significance of its activities have greatly increased and have won widespread recognition, both in this country and overseas.

Since the Association established its own laboratories in London in 1930, it has been found necessary to expand and extend the facilities and premises three times, and the latest of these additions—the completion of the main block fronting onto Euston Street was formally opened on May 13 of this year by Sir Alexander Fleck.

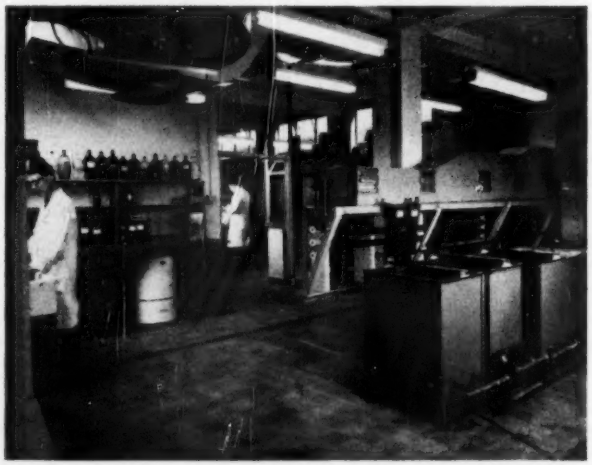
The block now completed adds another 12,500 sq. ft. of floor space to the laboratories, bringing the total to about 53,000 sq. ft. It contains new corrosion laboratories, a large new metal finishing shop, extensions to the physics laboratories and the foundry. In addition, there is a new Council room and offices for the senior staff more convenient to the main entrance. Completion of this building and other rearrangements and improvements will allow for a future expansion of about twenty per cent in most sections and will provide for some free space where equipment needed for only a year or two for a particular research project can be erected.

Particularly encouraging from the point of view of the metal finishing industry is the provision of an entirely new laboratory in the basement of the new building, housing the work on electroplating and allied finishing processes, which was formerly conducted in several scattered laboratories. The new laboratory is equipped for work ranging from bench-scale experiments on fundamental processes to plating on a semi-industrial scale. This makes it possible for industrial plating processes to be operated for study in the laboratories as well as enabling research and development work to be carried to the stage of pilot scale trials. The laboratory has equipment for measuring cathode potentials, throwing power, stress in electrodeposits and the ductility and adhesion of coatings.

The use of the laboratory roof as an exposure station and of the sulphur dioxide test in the development of which the B.N.F. played a prominent part, have contributed significantly to the recent work on assessing the performance of nickel/chromium plating in service. The results of this work have shown that durability of the finish is largely independent of the type of nickel deposited and of the period of operation of the bath, but that exterior performance is very greatly dependent on the actual thickness of the nickel coating. An important contribution to the non-destructive measurement of coating thicknesses has been the B.N.F. coating thickness gauge (see Metal Finishing Journal, April 1955). which is currently undergoing redesign to improve reproducibility, simplify calibration and speed-up readings.

Another factor which apparently exerts considerable influence on the corrosion resistance of nickel/chromium plating, is the normal highly crazed structure of the chromium deposit, as a result of which the inherently good corrosion resistance of chromium is lost. Research has been proceeding at the B.N.F. for several years with a

(*Continued in page* 245)



The new electroplating laboratory, of which a view is shown here, replaces the old pilot-scale plating shop and several scattered laboratories for more fundamental work

Zinc Coatings on Iron and Steel

(*Continued from page* 242)

soluble layer of calcium carbonate on the exposed steel surface. As this layer is impervious to the passage of both ions and electrons, it inhibits any further corrosive action. This reaction, depending as it does on the presence of dissolved calcium bicarbonate in the water, cannot occur in systems in soft water areas and consequently the protection afforded by zinc in these areas is not so effective.

It will therefore be seen that a zinc coating on steel provides three-fold protection. It operates in the first instance by providing a tough and adherent coating which seals the underlying metal from contact with its corrosive environment. If the coating is subjected to mechanical damage, it protects the exposed basis metal by rendering it cathodic and, in the last instance, it leads to the formation of subsidiary protective layers at such exposed zones.

While it is difficult to obtain a realistic figure for the annual cost of combating corrosion and its effects, recent estimates are of the order of £600,000,000 per annum for the U.K. alone. It is significant therefore to consider the contribution that zinc coatings can offer. The cost of application of a zinc coating by any of the methods described in the next chapter will almost certainly prove higher initially than that, for example, of a simple paint system. When, however, the cost of subsequent maintenance is taken into account, it will usually be found that the initial extra cost is more than compensated for by reduced maintenance costs. This is true whether a zinc coating is the sole protection applied or whether it is used as a preliminary to the subsequent application of paint, since paint applied over a zinc coating has a considerably longer service life than when it is applied direct to steel. Thus, not only is less frequent repainting required but far less preparatory work is involved on each occasion.

The economics of protection with zinc coatings vary with circumstances. It has for example been shown[3] that over a period of sixty years substantial economies can be obtained from the application of a zinc coating prior to painting the side sheeting of gas holders. Some of the criteria relating to this and other aspects of zinc coatings will be discussed in subsequent chapters of this work.

(*To be continued*)

References

(1) Vernon, W. H. J., *Institution of Civil Engineers*, London, 29 Nov. 1956.
(2) Evans, U. R., *Trans. Inst. Met. Finishing*., 31 (1954), pp. 106-119.
(3) Revald, L. A. Research Communication GC9. The Gas Council, London, 1953.

Overseas Review

(*Continued from page* 243)

plating bath, the use of a finely dry blasted steel surface and plating at a current density of 70 amp. per sq. ft. After plating, the parts are baked for 23 hours.

Automation and mechanisation seem to be the current watchwords for industry and an interesting account has been published of an American automatic hot dip galvanizing machine which will handle 3,000—5,000 lb. of parts per manhour ranging in weight from 1-100 lb., by either the basket or rack method[6].

Old But New

It is now just about 100 years since Thomas Graham employed selective diffusion across a membrane to separate the components of a solution. This technique known as dialysis was previous not commercially applicable to metal finishing because the parchment, Cellophane or similar membranes had poor chemical resistance. The development of modern vinyl plastic membranes[7] now means that the scope of dialysis is extended and is particularly valuable for the removal of acids from waste solutions. A typical application described in a most interesting article by Droran is the recovery of hydrofluoric and nitric acids from stainless steel pickling solutions.

References

(1) *Light Metal Age*, 1959, Vol. 17 (1/2), pages 8-10.
(2) *Plating*, 1959, Vol. 46, No. 4, page 384.
(3) *Metal Finishing*, 1959, Vol. 57, No. 2, pages 59-60.
(4) *Plating*, 1959, Vol. 46, No. 3, page 261.
(5) *Metal Progress*, February 1959, Vol. 75, No. 2, pages 19-93.
(6) *The Iron Age*, April 9th, 1959, Vol. 183, No. 15, pages 106-108.
(7) *Metal Finishing*, 1959, Vol. 57, No. 4, pages 52, 53.

New Metal Finishing Laboratory

(*Continued from page* 244)

view to finding means of producing chromium deposits thicker than 0.00002 in. without cracks. Studies of the effect of altering solution concentration and plating conditions have suggested modifications allowing modest increases in thickness of chromium and the extra durability to be obtained from these coatings is being determined at the present time. For much of the work, plated zinc alloy die-cast motor car trim is being used.

A novel feature of the new metal finishing laboratory is a small "hot" laboratory where weakly radioactive materials can be handled safely. Some of the organic chemicals normally added to plating solutions to modify the properties of the deposits are being labelled with radio-active tracers to facilitate the study of the mechanism of their operation.

NEW METAL-FINISHING LABORATORY

B.N.F.M.R.A. opens additional Research Block

SINCE the foundation of the British Non-Ferrous Metals Research Association nearly forty years ago, the scope and significance of its activities have greatly increased and have won widespread recognition, both in this country and overseas.

Since the Association established its own laboratories in London in 1930, it has been found necessary to expand and extend the facilities and premises three times, and the latest of these additions—the completion of the main block fronting onto Euston Street was formally opened on May 13 of this year by Sir Alexander Fleck.

The block now completed adds another 12,500 sq. ft. of floor space to the laboratories, bringing the total to about 53,000 sq. ft. It contains new corrosion laboratories, a large new metal finishing shop, extensions to the physics laboratories and the foundry. In addition, there is a new Council room and offices for the senior staff more convenient to the main entrance. Completion of this building and other rearrangements and improvements will allow for a future expansion of about twenty per cent in most sections and will provide for some free space where equipment needed for only a year or two for a particular research project can be erected.

Particularly encouraging from the point of view of the metal finishing industry is the provision of an entirely new laboratory in the basement of the new building, housing the work on electroplating and allied finishing processes, which was formerly conducted in several scattered laboratories. The new laboratory is equipped for work ranging from bench-scale experiments on fundamental processes to plating on a semi-industrial scale. This makes it possible for industrial plating processes to be operated for study in the laboratories as well as enabling research and development work to be carried to the stage of pilot scale trials. The laboratory has equipment for measuring cathode potentials, throwing power, stress in electrodeposits and the ductility and adhesion of coatings.

The use of the laboratory roof as an exposure station and of the sulphur dioxide test in the development of which the B.N.F. played a prominent part, have contributed significantly to the recent work on assessing the performance of nickel/chromium plating in service. The results of this work have shown that durability of the finish is largely independent of the type of nickel deposited and of the period of operation of the bath, but that exterior performance is very greatly dependent on the actual thickness of the nickel coating. An important contribution to the non-destructive measurement of coating thicknesses has been the B.N.F. coating thickness gauge (see Metal Finishing Journal, April 1955). which is currently undergoing redesign to improve reproducibility, simplify calibration and speed-up readings.

Another factor which apparently exerts considerable influence on the corrosion resistance of nickel/chromium plating, is the normal highly crazed structure of the chromium deposit, as a result of which the inherently good corrosion resistance of chromium is lost. Research has been proceeding at the B.N.F. for several years with a

(*Continued in page* 245)

The new electroplating laboratory, of which a view is shown here, replaces the old pilot-scale plating shop and several scattered laboratories for more fundamental work

Zinc Coatings on Iron and Steel

(*Continued from page* 242)

soluble layer of calcium carbonate on the exposed steel surface. As this layer is impervious to the passage of both ions and electrons, it inhibits any further corrosive action. This reaction depending as it does on the presence of dissolved calcium bicarbonate in the water, cannot occur in systems in soft water areas and consequently the protection afforded by zinc in these areas is not so effective.

It will therefore be seen that a zinc coating on steel provides three-fold protection. It operates in the first instance by providing a tough and adherent coating which seals the underlying metal from contact with its corrosive environment. If the coating is subjected to mechanical damage, it protects the exposed basis metal by rendering it cathodic and, in the last instance, it leads to the formation of subsidiary protective layers at such exposed zones.

While it is difficult to obtain a realistic figure for the annual cost of combating corrosion and its effects, recent estimates are of the order of £600,000,000 per annum for the U.K. alone. It is significant therefore to consider the contribution that zinc coatings can offer. The cost of application of a zinc coating by any of the methods described in the next chapter will almost certainly prove higher initially than that, for example, of a simple paint system. When, however, the cost of subsequent maintenance is taken into account, it will usually be found that the initial extra cost is more than compensated for by reduced maintenance costs. This is true whether a zinc coating is the sole protection applied or whether it is used as a preliminary to the subsequent application of paint, since paint applied over a zinc coating has a considerably longer service life than when it is applied direct to steel. Thus, not only is less frequent repainting required but far less preparatory work is involved on each occasion.

The economics of protection with zinc coatings vary with circumstances. It has for example been shown[3] that over a period of sixty years substantial economies can be obtained from the application of a zinc coating prior to painting the side sheeting of gas holders. Some of the criteria relating to this and other aspects of zinc coatings will be discussed in subsequent chapters of this work.

(*To be continued*)

References

(1) Vernon, W. H. J., *Institution of Civil Engineers*, London, 29 Nov. 1956.
(2) Evans, U. R., *Trans. Inst. Met. Finishing.*, 31 (1954), pp. 106-119.
(3) Revald, L. A. Research Communication GC9. The Gas Council, London, 1953.

Overseas Review

(*Continued from page* 243)

plating bath, the use of a finely dry blasted steel surface and plating at a current density of 70 amp. per sq. ft. After plating, the parts are baked for 23 hours.

Automation and mechanisation seem to be the current watchwords for industry and an interesting account has been published of an American automatic hot dip galvanizing machine which will handle 3,000—5,000 lb. of parts per manhour ranging in weight from 1-100 lb., by either the basket or rack method[6].

Old But New

It is now just about 100 years since Thomas Graham employed selective diffusion across a membrane to separate the components of a solution. This technique known as dialysis was previous not commercially applicable to metal finishing because the parchment, Cellophane or similar membranes had poor chemical resistance. The development of modern vinyl plastic membranes[7] now means that the scope of dialysis is extended and is particularly valuable for the removal of acids from waste solutions. A typical application described in a most interesting article by Droran is the recovery of hydrofluoric and nitric acids from stainless steel pickling solutions.

References

(1) *Light Metal Age*, 1959, Vol. 17 (1/2), pages 8-10.
(2) *Plating*, 1959, Vol. 46, No. 4, page 384.
(3) *Metal Finishing*, 1959, Vol. 57, No. 2, pages 59-60.
(4) *Plating*, 1959, Vol. 46, No. 3, page 261.
(5) *Metal Progress*, February 1959, Vol. 75, No. 2, pages 19-93.
(6) *The Iron Age*, April 9th, 1959, Vol. 183, No. 15, pages 106-108.
(7) *Metal Finishing*, 1959, Vol. 57, No. 4, pages 52, 53.

New Metal Finishing Laboratory

(*Continued from page* 244)

view to finding means of producing chromium deposits thicker than 0.00002 in. without cracks. Studies of the effect of altering solution concentration and plating conditions have suggested modifications allowing modest increases in thickness of chromium and the extra durability to be obtained from these coatings is being determined at the present time. For much of the work, plated zinc alloy die-cast motor car trim is being used.

A novel feature of the new metal finishing laboratory is a small "hot" laboratory where weakly radioactive materials can be handled safely. Some of the organic chemicals normally added to plating solutions to modify the properties of the deposits are being labelled with radio-active tracers to facilitate the study of the mechanism of their operation.

THIRTY YEARS OF METAL DEGREASING

Introduction of New Solvent Drier

THE value of trichlorethylene for metal degreasing was first recognized in the late 1920's ; it was found to have an almost ideal range of properties, namely non-inflammability, a boiling point of 86.7°C., a low heating requirement, a vapour 4½ times heavier than air and excellent grease-solvent powers. In addition, trichlorethylene could be purified by distillation.

The first metal degreasing plants operating on trichlorethylene were marketed in 1927 under the name of Crawshaw Chemical Colanders (Fig. 1) and were manufactured under licence from the General Chemicals Division of Imperial Chemical Industries, who in 1929 undertook the supply of the plants. I.C.I. already were making trichlorethylene, and a feature of their development work on the design of plants was the setting up of safety standards and the application of safety devices to the plants to offset the anaesthetic properties of the trichlorethylene. As is now well known degreasing is effected in the vapour or where necessary in the boiling solution.

The first open-topped plant was made by I.C.I. in 1931 and at the same time mechanized plants were introduced. Today plants both mechanized (Fig. 2) and manual can be tailor-made to suit any requirement and certain handling devices can be attached to standard plants. Movement of components through a plant can be by vibratory conveyor, mesh belt conveyor, pneumatic or electric lift, etc. ; in fact the process lends itself ideally to the application of mechanization.

The company have also developed a portable apparatus for the determination of the amount of trichlorethylene vapour in the atmosphere ; it is sensitive to as little as 2 part per million, and is a great advance over other portable methods, which were not so sensitive, and the laboratory apparatus with which it took 20 to 30 minutes to make a determination.

The 20,000th degreasing plant built by I.C.I. has recently been delivered.

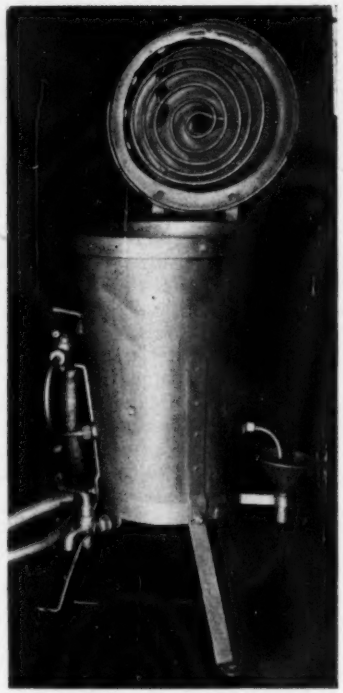


Fig. 1.—One of the original Crawshaw's chemical colanders supplied in 1927, intended for heating with a Bunsen burner.

Metal Drying

The most recent development is that of "Trisec," a special drying assistant for addition to trichlorethylene, that removes water from metal articles rapidly and thoroughly. It is well known that wet articles can be dried by immersing them in the vapour of a boiling chlorinated solvent and the moisture film dries off because although the boiling point of trichlorethylene is about 87°C. a mixture of the two boils at 73°C. Vapour degreasing

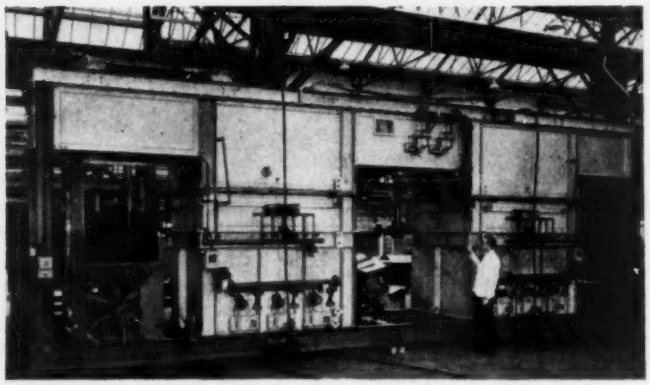


Fig. 2.—Continuous jetting and vapour plant for cleaning car and lorry wheels before enamelling: this uses trichlorethylene at 100 lb. per sq. in. in the enclosed jetting compartment. Supplied in 1957 to augment a similar plant supplied in 1948.

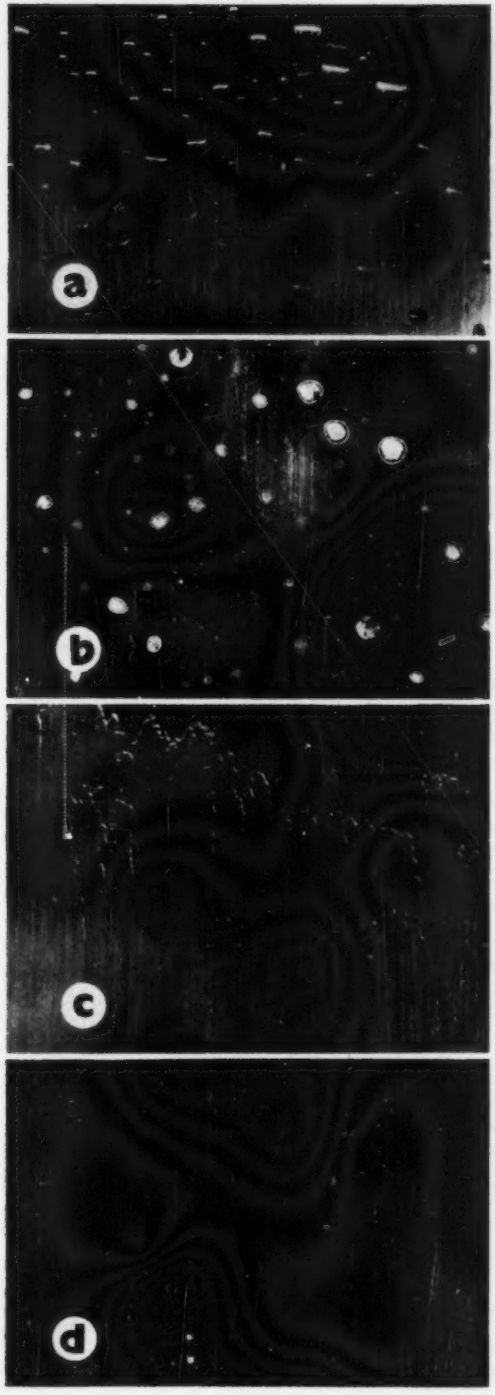


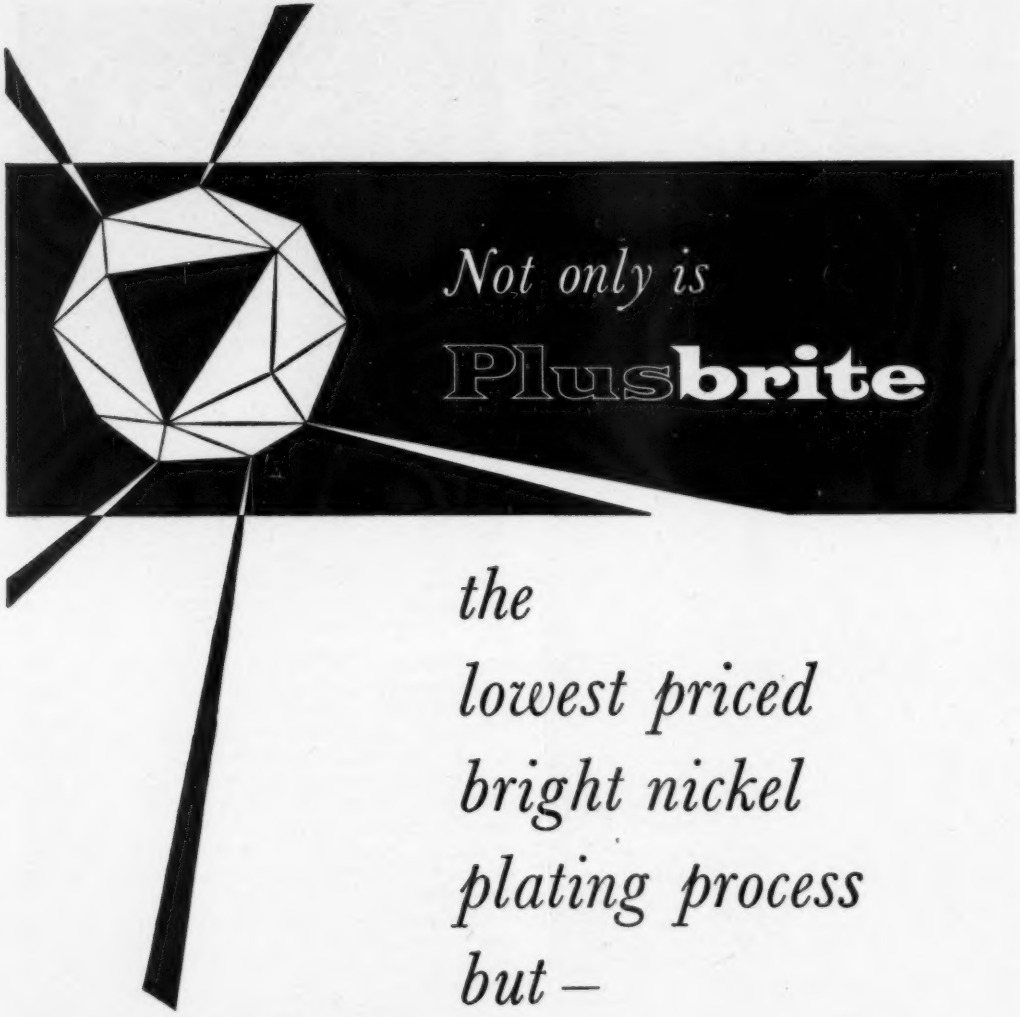
Fig. 3.—Droplets of water on a metal sheet (a) leave stains on evaporation as shown at (b). Immersion in trichloroethylene containing (Trisec) metal drying assistant displaces the water film (c) leaving no stain (d).

Fig. 4.—An L.V. 2 metal degreasing plant modified for use with Trisec metal drying assistant.

plants can therefore be used for drying although the evaporation of large water drops from the metal surface can cause staining of the metal (*see* Fig. 3).

With the new method trichlorethylene is still the drying medium but the treatment is in liquor instead of vapour; the liquor contains about one part of T isec to 80 parts of trichlorethylene. In action the water film on the metal is completely displaced so that the metal emerges from the final trichlorethylene rinse with a film of pure solvent which evaporates leaving no stains (*see* Fig. 3).

The treatment of free-draining articles is most effectively carried out in equipment similar to a standard LV type degreasing plant (Fig. 4) but incorporating a water separator, extra freeboard above water level and rim ventilation. One compartment contains the Trisec solution and is used for the drying operation while the second compartment containing trichlorethylene is used for rinsing. The whole process occupies about 1 minute. It is not recommended that greasy work should be introduced in the Trisec plant. A charge of the additive may be expected to last for 2 to 6 weeks after which a further addition equal to half the original charge should be added. The trichlorethylene should be topped up daily as required.



the lowest priced bright nickel plating process but –

it provides

* High ductility
* Excellent levelling
* Low internal stress
* Good receptivity to chromium plate
* Good colour

Plusbrite additive agents are not removed by continuous filtration, and they are easily controlled.

If you would like full technical information about this outstanding process write to

METAL FINISHING DEPARTMENT
ALBRIGHT & WILSON (Mfg) LTD
1 KNIGHTSBRIDGE GREEN
LONDON · SW1
TELEPHONE: KENSINGTON 3422

YBW/490

FINISHING NEWS REVIEW

Aluminium in building

A.D.A. symposium in London

A SYMPOSIUM on aluminium in building will be held by the Aluminium Development Association on July 9 and 10 at the Royal Institute of British Architects, 66, Portland Place, W.1. In the course of three sessions some fourteen papers will be introduced, reporting in detail the advances made—some of them very recent and significant to future trends.

There will be three sessions for discussion : aluminium as a building material; aluminium curtain walling; and aluminium building applications.

Growing use of material

In the past few years the uses of aluminium for building purposes have received considerable impetus from developments initiated in the aluminium industry and in allied trades. Scope for the architect and designer has been widened by new aluminium forms, such as larger extruded sections; by improvements in joining and finishing techniques; greater efficiency of design. Most significant of all are the more recent developments related specifically to architecture and building. Among these, aluminium curtain walls, new window sections, standard corrugated and troughed sheeting, and colour anodised aluminium for exterior use are outstanding. Address of the Aluminium Development Association is 33, Grosvenor Street, London, W.1.

PRODUCTION EXHBN. AND CONFERENCE NEXT APRIL

THE fourth International Production Exhibition will be held at Olympia (National Hall) from April 25-30 next year. Aim of the exhibition is to put on show, every two years, aids, techniques and processes that when applied to production result in greater efficiency at lower cost. A conference will take place simultaneously. Organisers' address is at 11 Manchester Square, London, W.1. Telephone: Hunter 1951.

Outdoor anodized finishes in B'ham Show

SOME of the leading figures in Birmingham's architectural and building circles, together with representatives of anodising and other processing firms, took part in a discussion on weather-resistant colour anodised finishes at the Midland Hotel, Birmingham last month. They also saw an exhibition of coloured sheet, sections and components in the full range of available colours.

The event was arranged by the Aluminium Development Association, London, whose member companies include a number of important wrought and cast aluminium fabricators in and around Birmingham.

Mr. F. C. Porter, M.A., A.I.M., a metallurgist from the Association, said that while plain or mill finishes are fully accepted for many architectural applications, the particular appearance given by anodising had an appeal of its own which could be considerably enhanced by the use of colour. Recent developments by the aluminium industry now made larger sheet, plate, section and castings available; moreover, the anodisers were now providing larger baths in which bigger components could be treated. He then described the range of colours shown in the exhibition—including bronze, gold, yellow, green, blue, black and variants on these—all of which have been proved by seven year exposure tests.

The exhibition was later moved to the entrance hall of the College of Arts and Crafts, Margaret Street, Birmingham where it was on public view for a fortnight. It showed examples of colour anodized aluminium made up into curtain wall panels, and demonstration pieces featured different combinations including cladding systems, spandrels and windows. There were also panels showing the full range of available colours both on plain aluminium and on silicon alloy aluminium.

Luton Foremen See Kent's Works

The Luton factory of George Kent Ltd. was visited last month by a party of nearly 80 members from the local Foremen and Staff Mutual Benefit Society. The company's mobile showroom came in for a very detailed inspection, and above can be seen one of the groups assembled outside.

Oxide layer is "built-in" insulation

Anodized foil and strip aluminium produced for electrical windings

COMMERCIAL production of continuously anodized aluminium foil and strip for electrical windings, particularly in magnets and transformers, is under way at Tyne Chemical Co. Ltd., River Drive, South Shields, where they are currently producing anodized material from 0.002-in. thick aluminium foil up to 0.06-in. strip in widths of a maximum of 12 in., continuously anodized in lengths of a 1,000 yards.

The breakdown voltage figure reached under this new technique is thought to be the highest yet obtained in this field. Flat windings of foil or strip with equivalent conductivity of a copper wire winding can be equal in volume, and in some cases smaller, even though the conductivity of aluminium in the 99 per cent to 99.5 per cent purity range is approximately 59 per cent to 61 per cent that of copper.

Aluminium in this form is claimed to provide an improved heat transfer rate across the coil eliminating the hot spots encountered in the circular cross section windings, and adjacent layers have only turn-to-turn voltage difference eliminating the need for thick layer insulation commonly associated with round wire windings.

Able to withstand overload

The company says that anodized foil or strip can safely withstand considerable periods of over-load, allowing designs to be of normal rating without providing for large safety factors. The simplicity of winding and the prospect of multi-winding machinery can step up production far more rapidly than with the traversing complications of conventional machinery, and aluminium strip and foil are basically much cheaper than their copper counterpart.

Oxide film build-up

The building up of an oxide film to enable aluminium foil or strip to be used as a conductor "sheathed" with its own insulation is the basis of the technique. The electro-chemical process of anodizing thickens the natural oxide layer from the "inside" of the film by passing a current in an acid electrolyte using the aluminium as the anode. Sulphuric chromic, oxalic, boric and phosphoric acids are used in various processes to give the required results.

Consistent thickness, density, hardness and absence of pores, together with flexibility of the film are all features which must be given careful consideration. Corrosion resistance of the anodic film varies with the alloys on which it is being produced, and is greatest on commercially pure aluminium and least on alloys containing large amounts of copper or zinc.

An indication of the toughness of the film is that when the basic metal is heated above its melting point, it will melt but still be retained in the film. The breakdown voltage depends on the alloys, film thickness, texture and moisture content but is not affected by increases in temperature up to 400°C.

Production range

The present production range of Tyne Chemical Co. is limited to 0.002 in. to 0.06 in. thick and up to 12 in. wide, but these limits depend on mechanical considerations and may well be extended in the future, the company says. The material is anodized uniform on both faces, thicker at the edges, in finished widths. Foil and strip are required to have a sound edge condition free from the edge weakness of slitting burrs.

"FERRODOR" SYSTEM ON BRUNEL BRIDGE

ISAMBARD Kingdom Brunel distinguished himself in the 53 years of his life as a brilliant engineer who constructed the more difficult portions of the Great Western Railway, besides many other famous engineering projects. 1959 marks the centenary of his death and also the centenary of the famous Royal Albert Bridge which he built at Saltash, across the estuary of the River Tamar about four miles west of Plymouth.

The bridge carries the Western Region's London to Penzance main line, and modern heavy locomotives of the Cornish Riviera expresses regularly traverse it.

The maintenance of all exposed surfaces of steel and ironwork is carried out with " Ferrodor " metal protection materials, a painting system based on micaceous iron oxide anti-corrosive paints for steel work.

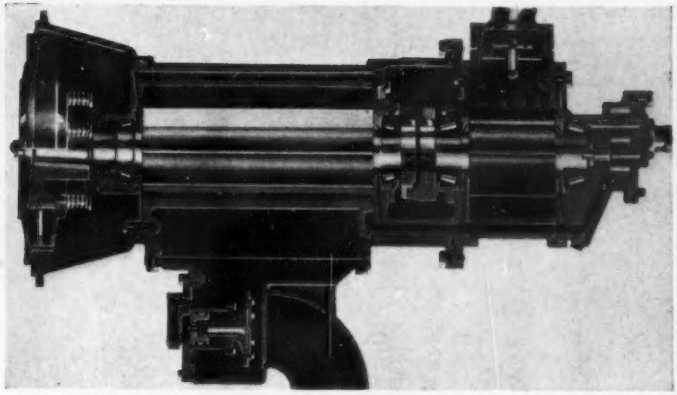
Records taken since 1947 show that approximately three stages of repaints have been found completely satisfactory to provide adequate protection with full regard to economy. The manufacturers of Ferrodor give their recommendations in their " Selective renovation plan for use by contractors," and the British Transport Commission supply the materials and indicate where they are to be applied by a diagram of the complete structure.

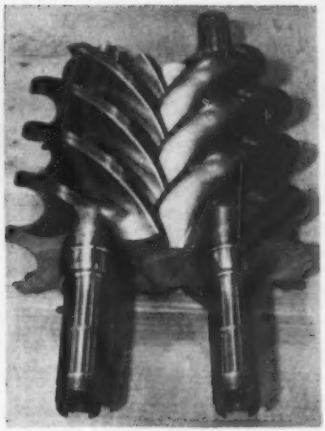
A.S.T.M. SPECIFICATION DOUBLES THICKNESS OF ELECTRODEPOSITED METALLIC COATINGS

ASTM Committee B-8 on Electrodeposited Metallic Coatings at its meetings held in Pittsburgh earlier this year, decided to double the specified nickel plate thickness in the Specification for Electrodeposited Coatings of Nickel and Chromium on Zinc and Zinc Base Alloys (B 142). This proposed change will be submitted to the Society for adoption at the Annual Meeting in June (week starting June 21, in Atlantic City). To improve the durability and performance of plated zinc die castings, the new coating designated Type DZ would have the following minimum thickness requirements: copper plus nickel, 0.002 in.; copper, 0.0002 in.; final nickel, 0.001 in.; and chromium, if required, 0.00001 in.

A proposed specification for electrodeposited coatings of nickel on steel for engineering use is being developed. This specification covers requirements for electroplated coatings of nickel on steel for engineering use where protection against corrosion, wear, abrasion, erosion, oxidation, or other deterioration of the basis metal is important, as well as product protection from iron contamination in vessels used for storage and handling of such materials. The type of nickel coating used will depend upon the requirements of the articles to be coated. Selection must be based on the experience of the manufacturer and the purchaser with regard to the thickness, hardness, ductility, residual stress, and other properties of the nickel coating.

A symposium on electroless nickel plating sponsored by the committee will be published in 1959. Eight papers and a bibliography will give detailed and comprehensive information on electroless nickel, and many photographs and tabular data will be included. Address of the A.S.T.M. is 1916 Race Street, Philadalphia, U.S.A.





A sectioned view of a rotary vane compressor, and (right) the internals of the screw type compressor.

B. of T. review highlights trend in compressor design

TRENDS in compressor sales evident from the latest statistics issued by the Board of Trade make interesting reading.

Total sales of compressors and exhausters were down last year by nearly 6 per cent, the overall pattern of the industry following the general trend of activity to a large extent. Within this general trend, however, some marked changes in the type of compressor being bought by industry are apparent, and nowhere is this more evident than in the rise in popularity of the rotary type of compressor, especially for portable operation.

Reciprocating type loses ground

Until 1954, portable compressors were commonly of the reciprocating type, using a cylinder and piston for the positive compression of air, with cooling effected by a forced air draught or by water circulated in jackets round the cylinders. In 1954, the first range of oil-flooded rotary power vane compressors as a series of models with capacities of up to 600 cu. ft. per min. at 100 lb. per sq. in. pressure, was introduced to the U.K. market.

These rotary vane compressors use a rather different principle from that of the reciprocating type, although again compression is by the positive displacement of air rather than the blowing action of turbines and rotary blowers. In the vane type unit, a rotor is positioned eccentrically in a cylindrical casing, the rotor bearing slots which houses a number of radial vanes. Thus as rotation takes place, the segments formed by the vanes pass through a continuous cycle of increasing and diminishing phases, air being admitted when the vanes are fully extended and ejected under pressure when they are fully receded into the rotor and the segment at its smallest volume. A particular point of this type of compressor is that it is oil flooded, the oil providing a ready medium for the removal of the heat of compression. Thus as the air is cooled at the time of compression, two staging is unnecessary for adiabatic reasons and no intercoolers are provided. One manufacturer, producing a compressor of this type of relatively small capacity has been marketing a single stage vane type compressor for over 10 years. In this unit, rotor and vane length are short and single staging is practicable. Manufacturers of the larger size of compressor commonly used, however, all utilise compression in two stages for mechanical reasons, the maximum compression ratio being of the order of 3.5 to 1.

Popularity of rotary vane type

In 1955, the first full year of marketing for larger portable oil flooded rotary vane compressors, some £215,000 worth of this type of plant was sold, as compared with the figure of £2,460,000 for portable reciprocating compressors. In the following years, these positions have been radically altered and during 1958, the rotary vane compressor accounted for almost one half of total portable sales, the figures for portable rotary and reciprocating machines being £1,434,000 and £1,529,000 respectively. The market for portable compressors showed a decline of some 17 per cent during 1958 as compared with 1957. This contraction was not, however, evenly shared, the sales for rotaries showing a 24 per cent improvement on 1957 figures whilst sales of portable reciprocating compressors fell by over 33 per cent.

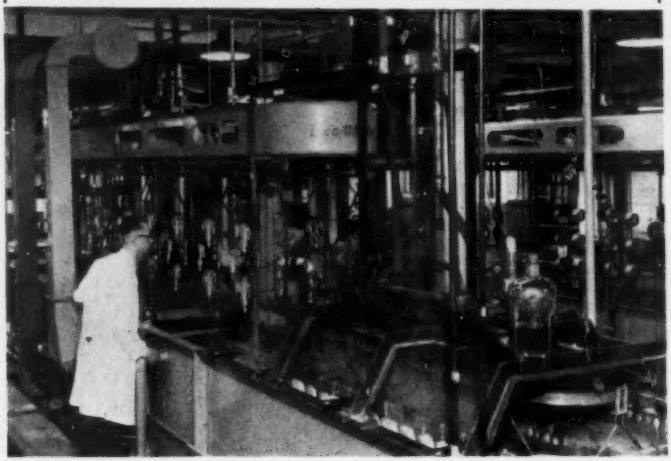
This tendency of portable reciprocating compressors has been noticeable since 1956. In that year, the portable compressor market expanded by 19 per cent, although sales of reciprocating compressors rose by less than 1 per cent, almost the entire expansion in the market being accounted for by sales of rotaries. In the following year (1957) the portable market expanded by only 5 per cent and during this year, reciprocating compressors lost ground to the extent of 7 per cent whilst rotaries gained by over 40 per cent.

Until the end of last year, the portable rotary was entirely of the vane type and in the five years since its introduction, it has succeeded in securing a half share of the total portable market. A newcomer to this field, however, is the portable screw compressor and it remains to be seen how much of a challenge this type of compressor will present to the market. As yet little operating experience is available and the two manufacturers in this field appear to hold divergent views on whether compression in two stages is necessary.

U.C.'s B'ham office

THE Alloys Division of Union Carbide has set up a new Birmingham office at 92, Newhall Street, Birmingham, 3. Telephone : Central 5011. Mr. Edward Pickard, southern area representative, is already at the new address.

Automatic Plating of Kitchen Ware



INSTALLATION AT METAL FINISHES

TWO fully automatic Efco-Udylite "Junior" electroplating machines have just been built and installed by the Electro-Chemical Engineering Co. Ltd., of Woking, Surrey, at the New Spring Street, Birmingham works of Metal Finishes Ltd. The firm of Metal Finishes Ltd. is the metal finishing division of Bulpitt and Sons Ltd., manufacturers of "Swan" brand hollow-ware and domestic and industrial electrical equipment. The machines are used for the bright nickel and chromium plating of electric kettle, percolator and toaster components, and their installation is enabling the company to achieve the consistent and high quality finishes that the market requires. Over 2 million components a year will be processed in these plants, each 37½ ft. long, 8 ft. wide and 8½ ft. high. The machines are of standard design and construction, although the process tanks have been provided to meet the customer's special requirements.

New Premises

THE Reddish Chemical Co. Ltd., makers of detergents for the dairy, brewery and industrial fields, have moved from Reddish, Stockport, to Globe Works, Stanley Road, Cheadle Hulme, near Stockport, Cheshire. Telephone: Hulme Hall 4406.

Sir George Earle Safety Trophy for Vauxhall Motors

THE Royal Society for the Prevention of Accidents announces that the Sir George Earle Trophy has been awarded this year to Vauxhall Motors Ltd.

The citation accompanying the trophy states that it has been awarded to the company "In recognition of more than 30 years of outstanding effort to ensure a safe working environment for their employees, particularly through the design and application of technical safety measures to meet constantly developing manufacturing techniques, and through the continuous attention paid to the safety aspects of the training of all levels of personnel, with particular regard to the apprentices, who have achieved a record of no lost-time injuries in 3,500,000 hrs. worked."

A.W.S. Corrosion Test Results

Information on Metallic Coatings Programme Ready

RESULTS of a corrosion test evaluation programme for metallized coatings after an exposure period of 3 years have been made available by the American Welding Society. The findings are claimed to be the only authoritative data on the corrosion resistance of this form of coating.

During the programme, over 4300 specimens were exposed at 8 test sites. The major objectives were to determine the life of the coating in each environment, to determine the effect of various methods of preparation of the steel, and to determine the increase in life of the zinc and aluminium coatings with seal coatings added.

12-year period at 3-year intervals

The Society's committee on metallizing selected locations where panels could be exposed to rural, industrial, salt-air and salt-spray environments. Panels were to be examined at 3, 6, 9 and 12 year intervals.

The results at the end of the first three years have been favourable, the Society says. All coatings tested indicate that they are fulfilling their primary purpose and are protecting the base steel. Illustrations of the actual panels, however, show a wide variation in the amount of discoloration. This is particularly noticeable when panels exposed to atmospheric conditions in New York, Chicago and the Gulf Coast are compared.

An illustrated reprint of the complete report giving test sites, test results, atmospheric exposure and a comparison of aluminium and zinc-sprayed panels, is available from the Society, Department T., 33 West 39th Street, New York 18, N.Y. Price 50c.

B.S. specifications at production conference

LORD Halsbury, president of the Institution of Production Engineers, opened this year's one-day conference of engineers and others concerned with the application of standards in industry. The conference — the fifth of its kind — was held on June 4 at the Connaught Rooms, London.

Theme of the morning session at the conference was the significance of standards in the national economy, their application in the individual company and the place and function in the company of the standards engineer.

Co-operation between the standards, design, and the purchasing departments in firms were discussed with particular reference to making British Standards more readily usable as purchasing specifications.

Industrial Training Council launches all-out drive in "Battle of the Bulge"

Extra school-leavers provide opportunity for industrial balance

WHEN the Industrial Training Council was set up last year, it took as its primary task the responsibility for trying to ensure that industry's training arrangements will be adequate to enable the best use to be made of the abilities of the young people who will be available for employment in industry during the next few years.

Improving the quality of training forms a main part of this task, but an essential prerequisite to this is that industry should step up its recruitment of young people, particularly during the bulge years of 1961 and the following two or three years.

The Council held a press reception in London last month to coincide with the issue of a statement to employers and trade unionists throughout the country, and to give an opportunity for its work to be discussed with the chairman of the Council, Lord McCorquodale, (a vice-president of the British Employers' Confederation), and with one of its members on the T.U.C., Mr. G. H. Lowthian (Amalgamated Union of Building Trade Workers). Also present were Mr. M. Y. Cobb, M.B.E., secretary to the Council, and Dr. A. B. Badge, the industrial relations officer of the Gas Council, who represents the nationalized industries on the I.T.C.

Provision of training officers

The bulge, representing a 20 per cent. increase over the normal influx of young people into industry, is not unmanageable, the Council says. They think the country will need every one of these children in the years ahead, but their training should not be left to chance, and it is industry's responsibility to plan ahead the action that will be necessary. In the statement just issued, all concerned are asked to treat the problem as a matter of urgency.

Part of a £75,000 government grant is to be used to set up a force of abour 50 training development officers. These would be appointed by the employers' joint councils. Their task would be to establish training courses and group training schemes ; if successful, the Council thinks a great stride forward will have been made, since many of the smaller industries are unable to employ a full time training officer.

Ratio of skilled to unskilled

The present fixed ratio of apprentices to skilled workers in many trades is under consideration with representatives of the trades unions. Since the unions were entirely sympathetic to the social question of training adequate numbers of skilled men, no difficulty was anticipated from this quarter.

Five committees had already been set up by the Council to examine various aspects of training, and these included the application of training methods, the recruitment and selection of entrants, and the study of foreign training schemes.

Firms who do not train

Firms who did not undertake the training of skilled men came in for criticism from Mr. Cobb. He said that in the engineering industry, like most others, it was the larger firms who did most of the training of skilled workers, but firms who did not train were not confined to any particular size. He compared these to passengers who travelled by bus without paying their fare.

To take apprentices as an example, he said, the aim was to get about 120,000 accepted as compared with the Ministry of Labour's figure for 1957 of about 93,000.

Period of training

In an exchange of views about the period of training, Mr. Lowthian said that in view of the new techniques now being introduced to many industries, this might have to be modified, and Lord McCorquodale said that the ending of national service was bound to have a modifying influence.

Recommendations about the length of training were contained in the Carr Report, and Mr. Cobb thought it was up to industry to consider these. The Council intend to issue a pamphlet on the subject in due course. He said that any suggestion that the engineering industry was averse to group training schemes was a matter of history, since they were reconsidering the proposals put forward in the Report about such schemes.

Training for the future

Group training schemes were not the only alternative to training a young person inside a firm. Mr. Lowthian mentioned his own industry where a boy was apprenticed not to a firm but to the industry.

Summing up, Lord McCorquodale emphasized that the executive body for training in industry must be comprised of members from individual organizations such as the employers' associations and the trade unions. The prime responsibility for a boy's (or girl's) training, however, rested with parents.

"Everyone needs some form of training," he went on. "To view the bulge with apprehension is the wrong outlook ; it is an opportunity to get a proper balance in industry, a balance between skilled and unskilled workers." He reminded his listeners that during the slackening off in industry recently, the largest numbers of unemployed were to be found among the unskilled, while skilled men were desperately needed by some industries.

As the statement to employers and trades unions points out, in the future new industries and new firms will require skilled labour which will have been trained by existing firms. When new skills are required, it will be easier to retrain people who have received some training for skill than to train the completely untrained.

Johnson, Matthey acquire interest in Italian precious metal firm

AN interest in the important Italian precious metal refining and manufacturing company, Metalli Preziosi S.p.A. of Milan, has been acquired by Johnson, Matthey and Co. Ltd. The company has a history of over 100 years of association with precious metals and is by far the largest enterprise of its kind in Italy.

It has its head office in Milan and its principal refineries and production centre in the new industrial zone of Paderno Dugnano, near Milan. Sales offices with local service facilities are maintained in 10 main towns. Extensions now in hand at the Paderno Dugnano works will presently complete a comprehensive modern precious metal metallurgical and chemical production plant worthy of Italy's rapidly expanding industrial economy.

Johnson, Matthey have already been working in close collaboration with Metalli Preziosi for a number of years. The closer association provides for technical as well as commercial integration and gives the Italian company access to the resources of the research organisation of the Johnson, Matthey group.

Technical & Industrial Appointments

Names in the news this month include Mr. Thomas Stone, who has left the Canadian diplomatic service to join International Nickel, and Dr. Robert Parker, who has taken over at Aluminium Laboratories, Banbury.

The appointment of Mr. Thomas Archibald Stone as special assistant to Mr. Henry S. Wingate, the president of **The International Nickel Co. of Canada Ltd.,** was announced recently.

Mr. Stone, Canadian Ambassador to the Netherlands from 1952 until the end of last year, has resigned from the Department of External Affairs at Ottawa.

Since entering External Affairs in 1926, and prior to becoming Ambassador to the Netherlands, he had served as Canadian Minister in Washington, Envoy Extraordinary and Minister Plenipotentiary to Sweden, and in other key posts in Ottawa, London and Paris.

In his new association with International Nickel, Mr. Stone will also serve as special assistant to the president of the company's United States subsidiary, The International Nickel Co. Inc. He will have his headquarters at that company's office in New York City.

* * *

Dr. Robert T. Parker has been appointed head of **Aluminium Laboratories Ltd.,** Banbury and Geneva offices in succession to Mr. R. D. Hamer.

Dr. Parker, an Associate of the Royal School of Mines, joined the Aluminium Limited Group in 1938 and transferred to Aluminium Laboratories Ltd. in 1946 as head of the metallurgical division. In 1950 he became director of research at the Banbury laboratories. He had previously been engaged in research with the British Non-Ferrous Metals Research Association. Dr. Parker is a Fellow of the Institution of Metallurgists and Fellow of the Royal Institute of Chemistry. For a number of years he has been chairman of the aluminium and magnesium industry committee of the B.N.F.M.R.A. and chairman of The Aluminium Development Association research committee, serving also on the Institute of Metals publication committee, B.N.F.M.R.A. research board and a number of government metallurgical committees. He is a past-chairman of the Oxford local section of the Institute of Metals.

* * *

Mr. R. Hadfield, a local director of **Thos. W. Ward Ltd.,** has been elected president of The Silica and Moulding Sands Association at the recent annual general meeting. He had been vice-president for the past two years.

Mr. Hadfield also represents his company on the councils of the Pig Iron Merchants' Association and the Foundry Coke Merchants' Association.

* * *

Mr. John G. Gershon, who for several years has been sales director and southern area sales manager of **Rocol Ltd.,** has relinquished the latter position, and will in future be concerned with the overall United Kingdom sales policy.

In his place, Mr. E. T. Wilkinson has been appointed area sales manager for the whole of the South of England.

* * *

Mr. G. S. Orr has been appointed manager of **Mobil Oil Co.'s** Scottish division, with headquarters at Glasgow. He succeeds Mr. A. Todd, who is retiring.

Mr. Orr joined the company in 1928, and held a series of appointments. In 1953, he was appointed branch manager, Northern Ireland, and in 1958, became district manager with the company's northern retail division at Newcastle.

Mr. A. Todd has been manager of the Scottish division since July, 1955. Prior to this he was branch sales manager at both Newcastle and Glasgow.

* * *

Short and Mason Ltd. announce that Mr. William K. Gregson has joined them as northern area representative and will operate from 32, Park Road, Sale, Cheshire.

* * *

The **O. Hommel Co.,** Pittsburgh, U.S.A., manufacturer of ceramic raw materials, has announced the appointment of Mr. John L. McLaughlin as district manager of vitreous enamel frit sales and service in the country's southern territory.

Mr. McLaughlin goes to Hommel with an extensive background in the vitreous enamel industry. He holds a B.Sc. degree in ceramic engineering from North Carolina State College and has served in executive capacities with Chicago Vitreous Corporation and Allied Porcenell, Inc. He has also been technical editor of Metal Products Manufacturing Magazine, and during World War II held the rank of Lt.-Col. in the U.S. Army.

Dr. R. T. PARKER
(Aluminium Laboratories)

Mr. J. G. Marsden, formerly of British Paints Ltd., Newcastle-on-Tyne, has joined **Anti-Dust Services Ltd.** as general sales manager in charge of U.K. sales. The appointment is an indication of Anti-Dust Services' widening scope of activities in the control and elimination of dust in industry.

Rapid growth of hardware industry in Hong Kong

THERE are now 31 factories engaged in the enamelware and nolloware press stamping industry in Hong Kong, providing employment for over 6,000 persons. Exports of enamelware to the U.K. have increased from £56 in 1952 to £550 for the first 9 months of 1958. Wage rates are agreed between employers and workers and are high by Far Eastern standards, being about 50% of U.K. rates, and overtime varies between 134 and 250% of ordinary time rates. Chinese new year bonuses are paid, and some workers receive free or subsidised food, and a small number free accommodation. A non-profit making research and testing laboratory for the industry has been established, and the industry is now concentrating on new designs and improvement of quality.

Home ware fair off

It is announced that the Domestic Equipment Fair, planned for Earls Court in September, 1959, has been postponed owing to difficulties beyond the control of the organisers.

TECHNICAL BOOKSHELF

Colour in Surface Coatings. (Its Appreciation, Measurement and Control). (Re-issue) Teddington : 1956. Compiled by the Research Association of British Paint, Colour and Varnish Manufacturers. Paint Research Station, Waldegrave Road, Teddington, Mddx. 68 pp. 7s. 6d.

This is a statement on the nature of colour in surface coatings, its characterisation and measurement and the practical use of the results so obtained.

It surveys a wide field of work on colour without resort to more than a small number of technical terms, and demonstrates many of the ways in which colour science can serve industry.

Much of that part of the text which is concerned directly with coating compositions is based upon laboratory investigations at the Paint Research Station. It is intended particularly for those within the related paint and colour industries who come into intimate contact with problems of colour, colour matching, colour standardisation, etc., in their day-to-day activities.

Flow Measurement and Control. Dr. W. F. Coxon. London : 1959. Heywood and Co. Ltd., Carlton House, Great Queen Street, London, W.C.2. 312 pp. plus 246 illust. 55s. net.

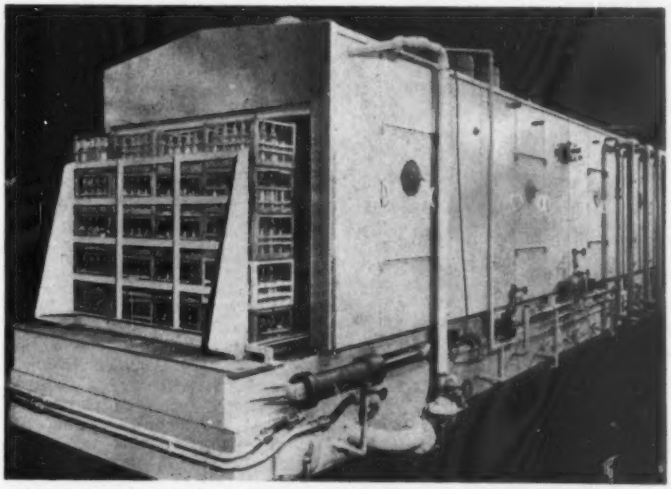
THIS book by Dr. W. F. Coxon is written to provide information on this subject for the young chemical engineer. It forms one of a series " Physical Processes in the Chemical Industry " under the General Editorship of Professor J. C. Robb and Dr. W. F. Coxon. To a large extent the theory of the subject has been avoided and the problems of flow measurement are discussed in terms of its practical importance. Reference is made to the basic considerations particularly of flow measurement by use of differential pressure and an explanation is given of the various terms used by the flow engineer. Descriptions of details of the various types of fluid meter are provided and reference made to the practical formulae used in British Standard 1042 : 1943. Various types of primary elements such as orifice plates, venturi tubes, etc., are covered including open channel meters. The remainder of the book is largely of a practical nature, considerable space being given to the location of pressure difference devices and typical instruments used such as mechanical and electrical flow meters and automatic regulators of the pneumatic, hydraulic and electronic type. The importance of flow measurement and control to automatic process control is discussed by reference to flow controllers and transmitters whilst a flow diagram of a hypothetical plant and its instrumentation is discussed in detail. The importance and application of flow control in the blast furnace, gas producer plants, open hearth furnaces, waste heat boilers, soaking pits and re-heat furnaces are also discussed as well as instrumentation and control for water and sewerage treatment. Reference is also made to flow measurement in relation to automatic boiler control. The author makes acknowledgement for the many practical plant layout illustrations which were provided by Electroflo Meters Co. Ltd.

Corrosion materials for Battersea summer school theme

THE sixth summer school on corrosion will be entitled "Newer materials for resistance to corrosion" and will be held in the metallurgy department, Battersea College of Technology, from September 28 to October 2, inclusive.

The lectures, given by authorities in their particular field, will deal with newer materials, metallic and non-metallic, for resistance to acqeous and high temperature corrosion. The topics will include: design in corrosion, nickel alloys, stainless steels, titanium, zirconium, tantalum, precious metals, plastics and coatings of plastics, fibre-glass, paints etc.

The course should be of particular value to chemical and corrosion engineers and metallurgists who want to obtain up-to-date information of developments in this field. Ample opportunity will be allowed for questions and discussions, the course organizers say. Address of the college is Battersea Park Road, London, S.W.11.



CONTINUOUS STERILISER FACED WITH "STELVETITE"

A CONTINUOUS steriliser has been built by the Graham-Enock Mfg. Co. Ltd. of Stamford Hill, London, N.16 for installation in a large Midlands dairy, with the plastic-coated steel sheet produced by John Summers and Sons Ltd. of Shotton, Chester. The machine comprises a tunnel, the base incorporating a series of conveyor chains which form an intermittently moving floor to carry stacks of crated bottles of milk through the tunnel for sterilising treatment.

The base, housing the conveyor chains and hydraulic cylinders that effect the intermittent movement, is constructed of electrically-welded steel plate in solid girder formation. The side walls and roof consist of insulated panels, and the outer sheet of these is in green "Stelvetite" panels, self-contained and mounted between a welded framing of steel angle and tee sections.

Production of raw materials

British Titan completes Grimsby plant extension

THE completion of a major extension to their titanium pigment producing plant at Grimsby has been announced by British Titan Products Co. Ltd. Construction has taken two and a half years and has cost over £2 million. The new project, planned entirely by B.T.P. staff, brings the total output of the Grimsby plant to 70,000 tons a year. It is concerned mainly with the manufacture of the various rutile grades of titanium pigments, supplementing the production of anatase grades at the B.T.P. plant at Billingham-on-Tees.

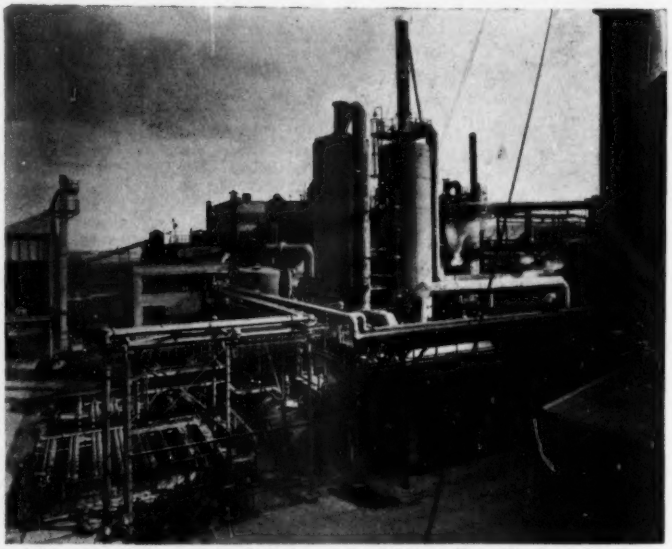
Automatic loading

New wagon-tipping plant and an automatic conveyor system feed a new ilmenite silo, with a capacity of 20,000 tons, loaded from the top. Ilmenite preparation plant including oil-fired drying and ball-mill grinding machinery, and a digestor unit with an output of 50 tons of TiO_2 per day has been erected. To cope with this capacity, a sulphuric acid plant capable of producing 180 tons a day has been included in the unit, together with ancillary power substations and air compressors. The plant is fully instrumented, production processes being regulated from centrally positioned control rooms, and provides the maximum information for recording statistics necessary for quality control at every stage of manufacture.

Titanium pigment production

The resultant titanium liquor produced by the new extension plant is pumped under pressure for refining and final stages of production at the main British Titan plant. The present stage of new building has been completed with the construction of a large new raw materials store.

The extension, as with the expanpansion of the Billingham plant, is part of the development programme planned by B.T.P. to keep pace with the growing demand for titanium pigments all over the world. The intense whiteness, opacifying power and durability of titanium dioxide is an advantage to the many pigment using industries, and it is widely used in paints, plastics, rubber, paper, cosmetics, textiles and carpets, linoleum and other floorings, vitreous enamels and industrial finishes.



The new acid plant at the Grimsby works of British Titan Products Co. Ltd.

Kelvin, Hughes order

MEMBERS of S.I.M.A., Kelvin and Hughes (Industrial) Ltd., have received an order for automatic ultrasonic inspection equipment to the value of £10,000 from KOVO, the Czech buying organization, for use in the rapid scanning of rolled mild steel bars.

Trade and Technical Publications

" Colourful Protection " is a well-produced booklet in colour by the Telegraph Construction and Maintenance Co. Ltd., Farnborough Works Green Street Green, Farnborough, Kent, profusely illustrated to depict the uses to which the company's Telcothene powder can be put for the protection against corrosion of many items of domestic and industrial equipment. The two methods of applying the coating are outlined under two main headings : dip coating and spray coating. A typical mass production line is also briefly described. Tables at the back of the booklet list the properties of the powder coating and its resistance to various chemicals.

* * *

A new " Surface Coating Resin Index " has been prepared jointly by the surface coating resin section of the British Plastics Federation and the Surface Coating Synthetic Resin Manufacturers' Association. The booklet, replacing a similar index published in 1955, aims at giving under one cover the basic information on all British-made surface coating synthetic resins at present available to the paint, printing ink and allied trades. It is available on application to the Federation at 47-48 Piccadilly, W.1, or to the S.C.S.R.M.A., at 79-80, High Holborn, W.C.1, price 5s., post free.

* * *

" Kuniform " is a leaflet issued by the Metals Division of I.C.I. Ltd., P.O. Box 216, Birmingham 6, to describe briefly their fine-grain copper alloy strip, designed to facilitate polishing of pressings. The alloy is claimed to eliminate the " graininess " that sometimes develops in pressings made from brass or gilding metals.

* * *

A new leaflet in the series dealing with the use of titanium in chemical plant has been issued by I.C.I. Metals Division. Called " Titanium for compressor valve plates and springs," the publication sets out the advantages claimed for the material in this particular application.

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

Plastic Plating Barrel

THE " EPE.12 " totally immersed cylindrical plating-barrel (Fig. 1) introduced by Sonic Engineering and Equipment Ltd., 120-130, Parchmore Road, Thornton Heath, Surrey, is made from treated, abrasion-resistant " Perspex," claimed to be resistant to all types of pre-cleaning and plating solutions at temperatures up to 80°C. It can be used effectively throughout the entire cleaning and plating cycle, eliminating unnecessary handling. In operation, the barrel is placed on the cathode rod and one anode rod in the plating tank, and current is fed through leads from the cathode rod connection to cathode contacts inside the barrel. A fractional h.p. motor, mounted at the top of the frame to rotate the barrel, can operate either on mains current or on 6 v. or 12 v. D.C. supply from the busbar or the anode circuit.

The barrel is suitably perforated so that the smallest sized parts can be properly processed and is fitted with a quick release lid for loading and unloading. A polythene version of the unit can be supplied for use with solutions at temperatures above 80°C., such as electroless nickel, while a hexagonal barrel can be provided if required. Overall length is 12 in. with a 6 in. dia. and a recommended process load of 10-12 lb. The " EPE.8 " a smaller version also available, has a barrel length of 8 in. : in both models, the barrel is fitted with tumbling strips. Barrel units can be supplied individually or with whatever types of tank are required, such as single plating units or complete cleaning, plating and rinsing installations for large scale production.

Parts that can be successfully plated in this type of barrel include safety pins, rivets, nails, all types of screws, bolts, nuts, washers and other small components. The barrel is also particularly suitable for use in the plating of precious metals, the makers say.

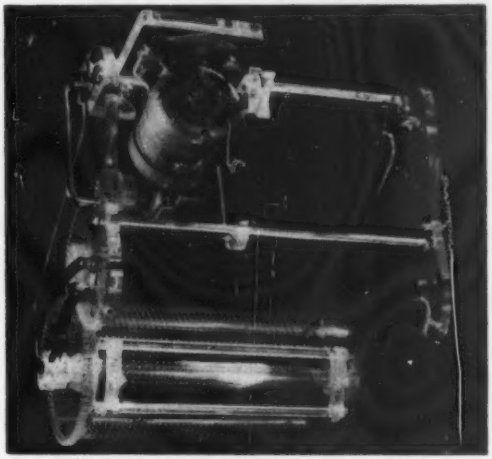


Fig. 1—The EPE 12 totally immersed cylindrical plating barrel is fitted with a fractional horsepower motor

Titanium Platinum Anodes

EARLY in 1958, Imperial Chemical Industries Ltd., Imperial Chemical House, Millbank, London, S.W.1, published brief preliminary details of research carried out by Metals Division into the use of titanium/platinum anodes. Indications were that titanium carrying very small deposits of platinum could be used for completely non-consumable anodes, a considerable practical advantage when used in various electro-chemical processes. Since then, subsequent work has identified more closely the fields in which titanium/platinum anodes have a particularly promising future, and the company have recently released details of these.

Titanium, though virtually immune to corrosion in brine, is not a suitable anode material because the protective oxide film that forms on its surface resists the passage of an electric current. Attempts to force a passage by using high voltages may result in failure of the film and severe local corrosion. The company says that this high resistivity is very much reduced when titanium is brought into electrical contact with a second metal. In particular, contact with platinum, deposited on the titanium either in strip or wire form or as a thin film, produces a very effective electrode system.

Most of the current is carried by the platinum, while the proportion carried by the titanium is sufficient to effect the anodic polarization of this metal and to ensure continuous maintenance of the oxide film. The phenomenon persists even if the titanium is exposed to the electrolyte by discontinuities in the platinum film and at current densities of more than 500 amps/sq. ft.

Among other applications, the bi-metallic anodes

are considered to be suitable for use in the cathodic protection of marine structures, and laboratory tests lasting many months have been carried out on titanium with very thin (0.0001 in. or less) coatings of platinum, operating in seawater or saturated sodium chloride at current densities of 200 amps per sq. ft. The company says that no case of failure occurred and there was no measurable loss of platinum. On a practical scale, the anodes are being used at Thames Haven, where 15,000 sq. ft. of steel piling is being protected by four small platinised titanium rod anodes 2-ft. long x $\frac{7}{8}$-in. dia. (compared with 60 ft. of $1\frac{1}{4}$-in. dia. rod in a more conventional material.) The rods have been in operation for some ten months at current densities varying from 68 amps per sq. ft. at high tide to 46 amps per sq. ft. at low tide. Voltage has remained constant at 23 volts throughout. The company says that although it is practicable to design an electrode system to operate at 200 amps per sq. ft., there is in practice an economic limit to the current density used. Present indications are that the economic range for platinised titanium anodes lies between 25 and 75 amps per sq. ft. It is claimed that by correct design within this range, the cost of anodes is comparable with, and on occasions less than, that of the more common materials.

In electro-descaling and electro-galvanizing, because it is not subject to metal loss, the company says that platinised titanium may offer useful advantages over other non-consumable anode materials. In cathodic descaling equipment for cleaning wrought stainless steel in acid media, and in the electro-galvanising of carbon steel wire in sulphuric acid/zinc sulphate electrolyte the bi-metal anodes should have a particular application. Another promising outlet is its use as anodes in rhodium plating baths. Experience has shown that, with the composite anode, while there is less evidence of gassing on the cathode surface, gas evolution at the anode occurs more readily. As a result, rhodium plating operations are carried out more efficiently and throwing power appears to be improved.

Air-operated Pump for Circulating Systems

ILLUSTRATED in Fig. 2 the Mark X pump is a larger addition to the range manufactured by Kingsbourne Products Ltd., South Coast Road, Peacehaven. The pump is being produced in cast iron, commercial brass, and stainless steel, and has a maximum delivery of 1,500 gal. per hr. of low viscosity liquid at level heads through an open bore.

In the construction of the "Neumo" pump, the body is divided into three main parts. The pump body proper is of cast iron with a honed bore, and the two identical valve chests are of

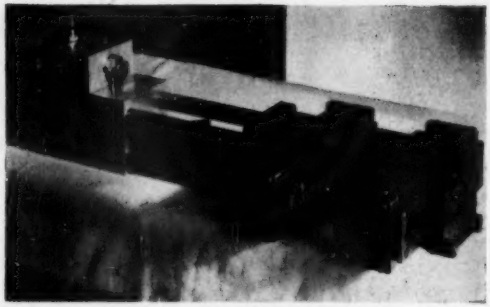


Fig. 2—An air-operated pump

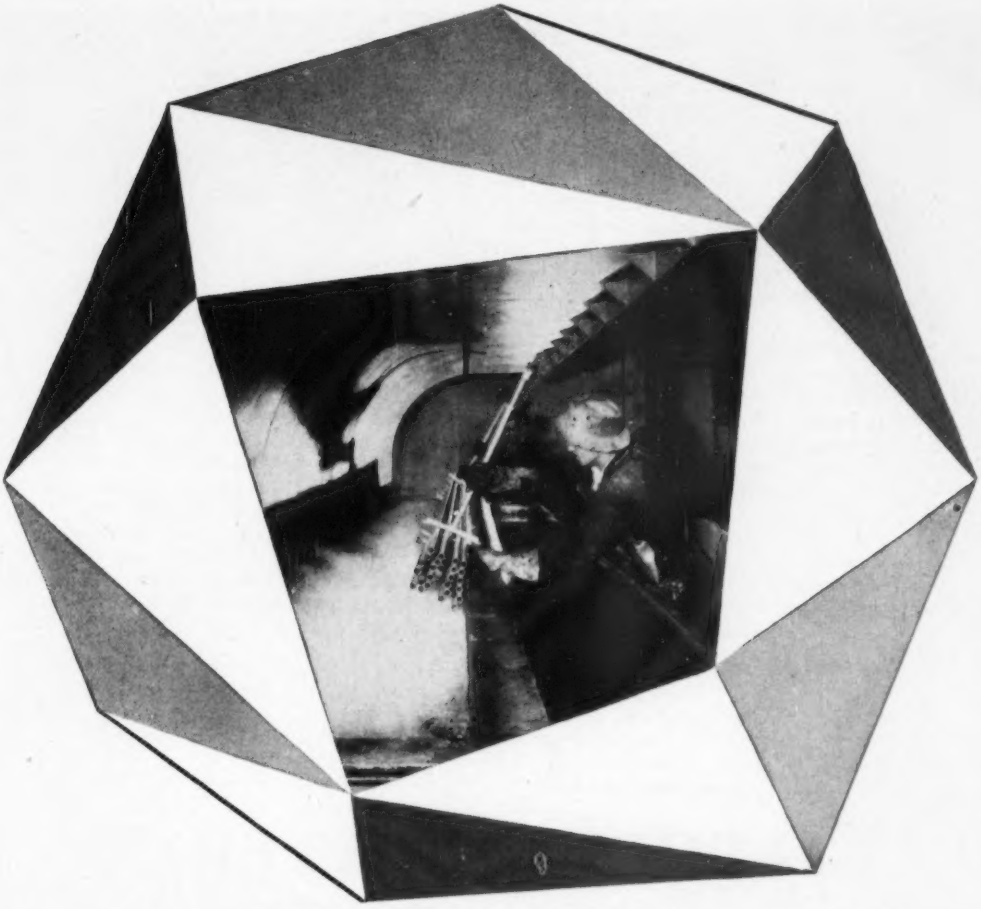
cast iron with the necessary ports and the four valves housed in reamed bores in these chests. Delivery or intake can be arranged on either side of the pump to suit any particular installation. The valves are of the spring loaded disc type with a hardened steel disc on a seat that is normally soft but that can be hardened if required. To ensure long life from the valves when pumping abrasive materials, the contours of the valve interior are of a form designed to reduce channelling to a minimum. Because the spring is trapped within a cavity by the disc when liquid is passing, no moving liquid comes into contact with the spring, thus avoiding undue wear. The plunger of the pump consists of a piston fitted with spring-loaded "Fluon" piston rings. The pumps can be made in various materials to suit specific requirements.

One of the interesting features of the pump is that by regulation of the air supply to the motor, the unit can be caused to stall when a certain outlet pressure has been reached. If the air is allowed to remain connected, immediately upon any drop of pressure on the outlet side, the unit will automatically start pumping again until the required pressure is once again reached. On the same principle, the unit would automatically take care of any sudden leaks by speeding up, provided the delivery plus the leaks did not exceed the total capacity of the pump.

The makers say the pump is particularly suitable for paint circulating systems in paintshops. They say that recently a complete circulating system, employing the much smaller Mark IV pump unit, was installed in the premises of a manufacturer of domestic appliances, where it was used to circulate sufficient paint to supply two hotspray equipments and at the same time to keep the system flooded.

Fibreglass Containers

CONTAINERS manufactured from fibreglass and bonded with polyester resin, for the storage and handling of corrosive and dangerous powders, are being produced by Turner and



The largest **PHOSBRITE** *plant in Britain*

Installed at the Birmingham plant of Haynes, Ford & Elliot Ltd is the largest Phosbrite plant in Britain. The 600 gallon tank is particularly interesting not only for its size but also because of the variety of items being chemically polished – from wheel discs to curtain rails – from wash boiler tubs to decorative light fittings. This plant proves without doubt that *CHEMICAL POLISHING WITH PHOSBRITE SOLUTIONS SAVES TIME & MONEY.*
Phosbrite 159 for Aluminium and its Alloys. Phosbrite 183 & 184 for Copper and its Alloys
Phosbrite 501 for electrolytic polishing of Stainless Steel and Alloys
For full technical information write to

Metal Finishing Department
ALBRIGHT & WILSON (MFG) LTD
1 Knightsbridge Green, London SW1
Telephone: KENsington 3422

TRW/633

Plant, Processes and Equipment

(*Continued from page* 258)

Brown Ltd., Davenport Works, Bolton, Lancs. The containers can be stored in the open, since the mild steel-angle frame is completely sealed within the material. A flange surmounting the filler neck is moulded from fibreglass and has bolts equipped with wing nuts around its periphery to secure a P.V.C. cap complete with Neoprene gasket. One typical example being produced for the U.K.A.E.A. is 2 ft. sq. x 2 ft. 7 in. deep, capable of holding 900 lb. of uranium powder.

Lightweight Angle-sander

A NEW lightweight angle-sander, the CP 3017 AWS, on which "Flexback" pads can be fitted for wet sanding of irregularly shaped surfaces, has been introduced by the Consolidated Pneumatic Tool Co. Ltd., 232, Dawes Road, London, S.W.6.

The sander is available in three versions with spindle speeds of 4500, 2700 and 1500 r.p.m. (Fig. 3). The motor in each case consists of a high power "unit type" vane motor that incorporates a floating rotor. Thus, while more power is claimed than with other types of motor, end-plate wear is eliminated. Ball or needle bearings are used for all revolving parts and lubrication of the motor is by a built-in oil reservoir, the gearing being lubricated through a convenient filler plug without disassembly of the gearing.

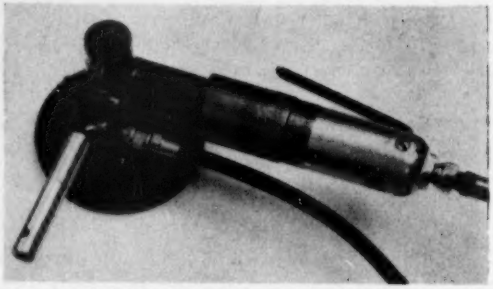


Fig. 3.—A lightweight angle sander suitable for treating irregularly-shaped surfaces

Water feed to the sanding pad is by a water connection feeding through the spindle shaft and the tool is supplied for operation from a $\frac{1}{2}$-in. dia. air hose, a $\frac{1}{4}$-in. female-thread inlet being fitted. A lever type throttle is standard and this is used in conjunction with a dead handle. The sanders are designed for operation with either 5-in. or 7-in. rubber pads or 7-in. "Flexback" pads.

RS

ELECTRO-PLATERS

A.I.D., A.R.B. & I.A. Approved

ELECTRO-PLATING—Chrome, Copper, Nickel, Cadmium, Silver, Zinc, Bright Nickel, Bronze, Tin, etc.

ANODISING—Chromic and Sulphuric Acid processes. Decorative Silver Anodising and Sealing in longest dimensions a speciality.

STOVE ENAMELLING · CELLULOSING · CHROMATING
PHOSPHATING · PASSIVATING · LACQUERING

OUR FACTORY, *equipped with a large, modern and efficient Plant, can undertake all types of Metal Finishing.*

24-HOUR SERVICE *on repetition work.*

FREE *collection and delivery.*

ROBERT STUART (LONDON) LTD.

ASCHAM STREET, KENTISH TOWN, N.W.5

Tel.: GULliver 6141 (six lines)

B.T. Anodising & Plating Co. Ltd change to

PHOSBRITE *159*

This company previously using an electrolytic process, finds that chemical polishing with Phosbrite 159 is much easier to control and much more versatile.

Since the installation of the plant towards the end of 1958, output has trebled, and if the present trend of output continues, it is eventually intended to double the size of the existing plant.

Chemical polishing with Phosbrite solutions not only saves time and money–but promotes successful development as well.

For full technical information write to the address below.

Metal Finishing Department
ALBRIGHT & WILSON (MFG) LTD
1 Knightsbridge Green, London SW1
Telephone: KENsington 3422

HIGH GRADE
FLUORSPAR

GUARANTEED SPECIFICATION
98%
CaF_2

GLEBE MINES LIMITED ARE THE LARGEST PRODUCERS OF REFINED FLUORSPAR IN GREAT BRITAIN

IMMEDIATE DELIVERY IN BULK OR IN BAGS!

ALSO PRODUCERS OF HIGH GRADE BARYTES AND LEAD CONCENTRATES

GLEBE MINES LIMITED

EYAM, NEAR SHEFFIELD. Tel: EYAM 286. Grams: FLUORIDES

To the PUBLISHER

METAL FINISHING JOURNAL

Telegrams: ZACATECAS, RAND, LONDON

JOHN ADAM HOUSE
17/19 JOHN ADAM STREET
ADELPHI, LONDON, W.C.2

Telephone: TRAFALGAR 6171

Please send me the **Metal Finishing Journal** to the address given below until countermanded, and invoice me in the sum of **£1.4.0** (U.S. & Canada: **$3.50**) in respect of the first year's subscription.

Name.....

Address.....

Date.....

Cheques and Post Office Orders to be made payable to:—**INDUSTRIAL NEWSPAPERS, LTD.**

WALTERISATION
REGISTERED TRADE MARK

THE
WALTERISATION
CO. LTD.
PURLEY WAY, CROYDON
ENGLAND

Telephone: CROydon 2791 (4 lines)

Telegrams: Rustproof, Croydon

Agents
Stockists and Distributors throughout the world

USED BY LEADING MANUFACTURERS

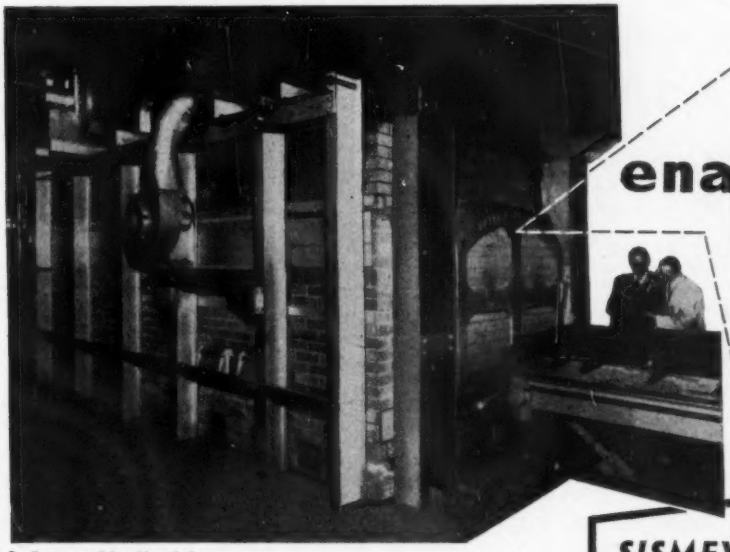
WALTERISATION
Regd. Trade Mark
QUALITY PHOSPHATE RUSTPROOFING BY IMMERSION

FASBOND
Regd. Trade Mark
PAINT BONDING BY IMMERSION OR SPRAY

DERAN
Regd. Trade Mark
REMOVES RUST BY IMMERSION

FOSCOTE R.S.
Regd. Trade Mark
DESTROYS RUST—A COLD PHOSPHATING PROCESS APPLIED BY BRUSH OR SPRAY

WALTERGEL
PRODUCT FOR THE REMOVAL OF HEAVY SCALE ON STEEL



By Courtesy of Aga Heat Ltd.

enamelling muffles

15 FT. MUFFLE FUSING HEAVY LOADS CAST IRON ON 6-7 GALS. OIL PER HOUR.

SISMEY & LINFORTH Ltd.

241 ALCESTER ROAD SOUTH · BIRMINGHAM 14

TELEPHONE: HIGHBURY 1369 · TELEGRAMS: SISMEY, BIRMINGHAM.

Before

you

paint

take off all dust with an

ad taccy rag

Complete dust elimination assists paint drying and adhesion, reduces rubbing down, enables thinner coats to be used, cuts down rejects and touching up, eliminates film weaknesses. AD Taccy Rags ensure perfect finishes.

SAVE TIME, EFFORT AND COSTS

Four types for maximum efficiency and economy cover every finishing need.

ANTI-DUST SERVICES LTD

P.O. BOX 28 · DUDLEY · WORCESTERSHIRE

pH AT YOUR FINGER TIPS!

INSTANT pH READINGS ANYWHERE

A truly portable POCKET pH METER, whose range is from 0 to 14 pH, with an accuracy better than 0.1 pH Units.

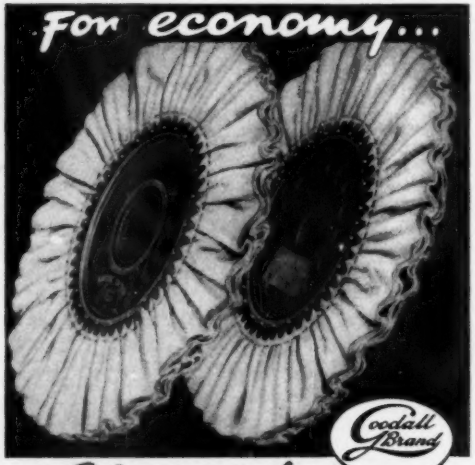
This unique instrument is completely temperature compensated, and is supplied with the revolutionary ANALYTICAL pH PROBE UNIT making possible on-the-spot readings anywhere.

ANALYTICAL MEASUREMENTS LTD

Dome Buildings, The Quadrant, Richmond, Surrey

Telephone: RIChmond 3392

For economy...



aircool

BIAS BUFFS

If you wish to consult us about reducing your buffing costs write or phone and a technical representative will call and give you full details and advice.

Telephone BLOXWICH 76251

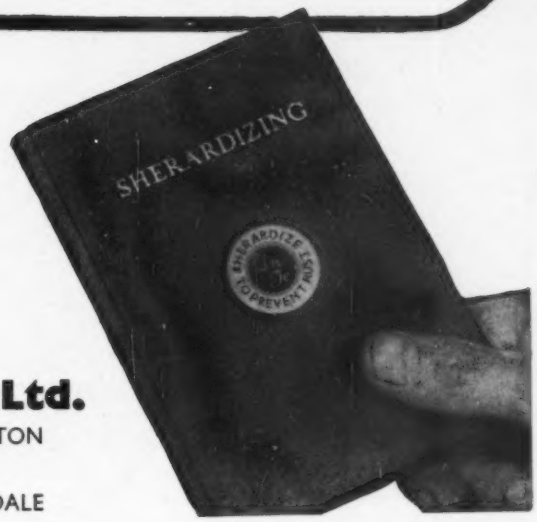
JOHN HAWLEY & CO. (WALSALL) LTD.

GOODALL WORKS BLOXWICH ROAD WALSALL STAFFS

YOURS *for the Asking*

LEARN HOW TO :—
SPECIFY,
TEST,
USE,

SHERARDIZING



Write to :—

ZINC ALLOY
RUST-PROOFING Co. Ltd.

SHAKESPEARE STREET, WOLVERHAMPTON
Telephone : Wolverhampton 20647/8/9
And at LONDON at ROCHDALE

CHILLED IRON ABRASIVES

ANGULAR GRIT **ROUND SHOT**

BSS GRADES AT COMPETITIVE PRICES

PROMPT ATTENTION TO ALL ENQUIRIES FROM THE ENAMELLING INDUSTRY

BILSTON SHOT & GRIT CO. LTD.

(BRANCH OF NORTON INDUSTRIES LTD.)

TELEPHONE
BILSTON 41961/2/3

SPRING ROAD,
ETTINGSHALL, WOLVERHAMPTON

ENAMELS & FRITTS

COLOURING OXIDES

MANUFACTURED BY

STOKE-ON-TRENT

Tel. STOKE-ON-TRENT 25126/7

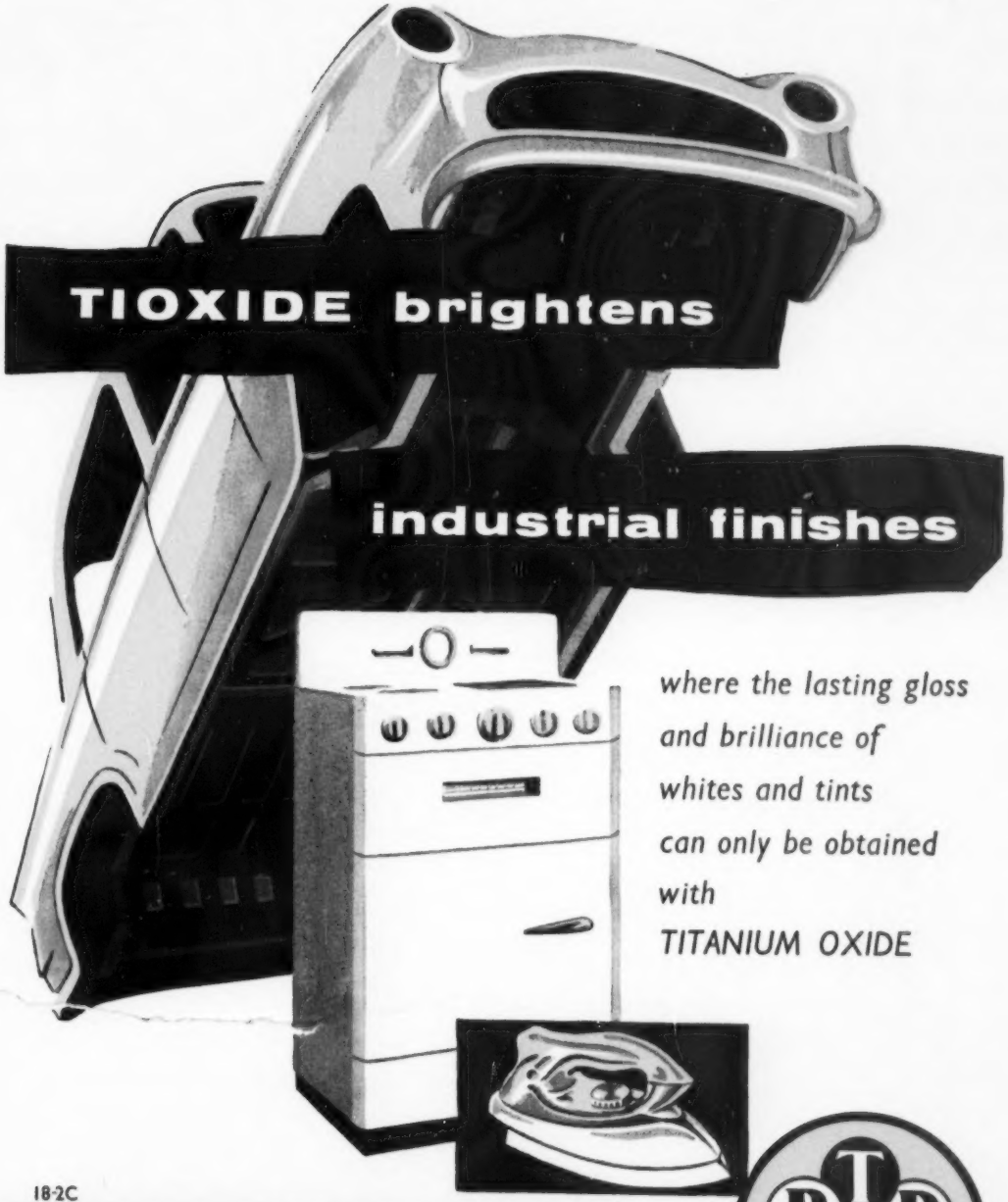
FOUNDED 1870.

POWDERED WHITE ENAMELLING CLAY

INDEX TO ADVERTISERS

	Page
Aerograph Co. Ltd.	—
Albright & Wilson (Mfg.) Ltd.	248, 25 & 27
Alkan, M. L., Ltd.	—
Almco Ltd.	—
Alumilite & Alzak Ltd.	—
Analytical Measurements Ltd.	30
Anti-Dust Services Ltd.	30
Atlas Copco (Great Britain) Ltd.	3 & 15
Ballard, F. J., & Co. Ltd.	16
Bilston Shot & Grit Co. Ltd.	31
Blythe Colour Works Ltd.	2
Borax & Chemicals Ltd.	14
Borax Consolidated Ltd.	22
British Chrome & Chemicals Ltd.	—
British Paints Ltd.	19
British Titan Products Co. Ltd.	33
Brotherton & Co. Ltd.	—
Canning, W., & Co. Ltd.	8 & 13
Chemical Engineering Construction (Pensnett) Ltd.	—
Cruickshank, R., Ltd.	—
Dawson Bros. Ltd.	24
Electro Chemical Engineering Co. Ltd.	10
English Abrasives Corporation Ltd.	4
Escol Products Ltd.	1
Ferro Enamels Ltd.	—
Gas Council	6 & 7
Glebe Mines Ltd.	28
Glostics Ltd.	18
Griffiths, A. E., (Smethwick), Ltd.	5
Hawley, John, & Co. (Walsall) Ltd.	30
Hockley Chemical Co. Ltd.	20
Imperial Chemical Industries Ltd.	17
Impregnated Diamond Products Ltd.	18
Incandescent Heat Co. Ltd.	—
Kemball, Bishop & Co., Ltd.	—
Laporte Chemicals Ltd.	21
Laporte Titanium Ltd.	11
Main Enamel Manufacturing Co. Ltd.	12
Metals & Methods Ltd.	—
Metropolitan-Vickers Electrical Co. Ltd.	—
Minnesota Mining & Manufacturing Co. Ltd.	—
Mond Nickel Co. Ltd. (The)	—
Morris, B. O., Ltd.	9
Nash & Thompson Ltd.	—
Newton Plating Jigs & Insulations Ltd.	34
Nu-Way Heating Plants Ltd.	—
Pascall Engineering Co. Ltd.	—
Peabody, H. W., (Industrial) Ltd.	—
Pye, W. G., & Co. Ltd.	—
Pyrene Co. Ltd.	—
Shell Chemical Co. Ltd.	—
Silvercrown Ltd.	—
Sismey & Linforth Ltd.	29
Stordy Engineering Ltd.	—
Stuart, Robert, (London), Ltd	26
Summers, John, & Sons Ltd.	—
T.C. Spray Finishing Systems	14
Thompson Bros. (Bilston) Ltd.	—
Ultrasonic Applications Ltd.	—
Volspray Ltd.	—
Wallace & Tiernan Ltd.	—
Walterisation Ltd.	29
Wengers Ltd.	32
Zinc Alloy Rust-Proofing Co. Ltd.	31

Published by the proprietors INDUSTRIAL NEWSPAPERS LTD., John Adam House, 17-19 John Adam Street, Adelphi, London, W.C.2, and printed by F. J. PARSONS, LTD., London, Folkestone and Hastings.



where the lasting gloss and brilliance of whites and tints can only be obtained with TITANIUM OXIDE

18-2C

British Titan Products Co Ltd
10 STRATTON STREET LONDON W 1

BTP
TITANIUM PIGMENTS

metal finishing Journal

PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, METAL SPRAYING and all METAL-FINISHING PROCESSES

Founded 1930 as the INDUSTRIAL FINISHING JOURNAL

Vol. 5 No. 54 (New Series) JUNE, 1959

DEFINITELY...

Quality . . .
Design . . .
Service . . .

and
competitive prices
guaranteed by . . .

THE FINEST PLATING JIGS IN THE TRADE

NEWTON PLATING JIGS AND INSULATIONS LTD.
13 STRAFFORD ROAD, ACTON, W.3
Telephone : Acorn 6157

Midland Representative : D. BRADBURN, 222 Westwood Road, Sutton Coldfield, Birmingham.